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# Pilot Study of Sampling and Analysis for Polynuclear Aromatic Compounds in Indoor

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# PILOT STUDY OF SAMPLING AND ANALYSIS FOR POLYNUCLEAR AROMATIC COMPOUNDS IN INDOOR AIR

by

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This report presents the results of a nine-home indoor air study that we performed in Columbus, Ohio in the winter of 1984. The main objective of the study was the field evaluation of sampling and analysis methodology. However, several additional results of the study are interesting and useful, including the finding of polynuclear aromatic hydrocarbons (PAH) at levels from 0.000 to 143 ng/m$^3$ in resdences, strong correlations of these levels with smoking by occupants, little influence of fireplace use on the PAH levels, the identification of quinoline as a potential marker for cigarette smoking, and measurement of 2- and 3-nitrofluoranthene, which are potent mutagens, at significant levels from 0.000 to 0.185 ng/m$^3$, also correlated with smoking.

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# FOREWORD

Measurement and monitoring research efforts are designated to anticipate environmental problems, to support regulatory actions by developing an in-depth understanding of the nature and processes that affect health and the ecology, to provide innovative means of monitoring compliance with regulations, and to evaluate the effectiveness of health and environmental protection efforts through the monitoring of long-term trends. The Environmental Monitoring Systems Laboratory, Research Triangle Park, North Carolina, has responsibility for: assessment of environmental monitoring technology and systems for air, implementation of agency-wide quality assurance programs for air pollution measurement systems, and supplying technical support to other groups in the Agency including the Office of Air and Radiation, the Office of Toxic Substances, and the Office of Solid Waste.

The determination of human exposure to toxic organic compounds is an area of increasing significance to EPA. The development, evaluation and testing of sampling and analysis methodology to characterize the concentrations of semi-volatile aromatic organic compounds in air within a microenvironment provide an important step toward measurement of, and understanding, the extent of human exposure to the polynuclear aromatic compounds.

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# ABSTRACT

The objective of this project was to evaluate and test generic sampling and analysis methodology for characterization of polynuclear aromatic hydrocarbon (PAH) concentrations in ambient and indoor air. Sources responsible for variations in PAH concentrations in indoor air were identified from statistical analyses.

Preliminary studies of polyurethane foam (PUF) cartridges were conducted to determine whether PUF cartridges can be used to collect vapor phase PAHs. A modified PUF cleanup procedure that combines compression rinsing and Soxhlet extraction was developed to remove interfering material from the PUF cartridges. It was demonstrated that PAHs can be extracted from the PUF cartridges by Soxhlet extraction, which has previously been used successfully for polychlorinated biphenyls. Investigation of the retention characteristics of PUF cartridges for PAH showed that, after exposure to about 100 $m^3$ of air at -10°C to 0°C, most of the spiked PAHs, except for a few highly volatile and reactive compounds, were retained on the PUF cartridges.

Residential air sampling was conducted in Columbus, Ohio during the winter of 1983/84 to determine the effects of the following parameters on PAH concentrations in air within residences: cigarette smoking, use of woodburning fireplaces, type of home utilities, and ambient air intrusion. A modified EPA medium volume sampler having a quartz fiber filter to collect particulate matter and a PUF cartridge to trap vapors was used. The determination of PAHs and related compounds was accomplished using on-column injection fused-silica gas chromatography with both positive and negative chemical ionization/mass spectrometric detection in the multiple ion detection mode. The target compounds determined in the air samples were 15 PAHs, 2 nitro-PAHs, and 2 nitrogen heterocycles. The levels of PAHs and nitrogen heterocycles detected in outdoor ambient air and indoor air samples were generally less than 100 ng/$m^3$ for compounds found at higher levels and less than 1 ng/$m^3$ for compounds found at lower levels. Both nitro-PAHs (2-nitrofluoranthene and 1-nitropyrene) were always found at very low levels (<0.1 ng/$m^3$) with the former compound always occurring at higher levels than the latter by a factor of 2 to 10.

Statistical analyses of the data involved the generation of summary statistics (e.g. means, standard deviations) for the observed concentrations of target compounds as well as statistical modeling to assess the separate influences of each of the four parameters above. The statistical analyses showed that the type of heat source and appliances (gas versus electric) and cigarette smoking had the greatest effects on the PAH levels found in the air in residences. The use of woodburning fireplaces was only weakly correlated with target compound levels. Outdoor air intrusion had statistically significant effects on indoor air PAH levels for only a few compounds.

This report was submitted in fulfillment of Contract No. 68-02-3487 by Battelle Columbus Laboratories under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period of February 1, 1984 to September 30, 1984, and work was completed as of October 30, 1984.

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# SECTION 1

# INTRODUCTION

Polynuclear aromatic hydrocarbons (PAHs) and nitro-substituted polynuclear aromatic hydrocarbons ($NO_2$-PAHs) have been identified in organic extracts of ambient air particulate matter(1,2) and diesel exhaust particulate matter(3). Many of the identified PAHs and $NO_2$-PAHs are potent carcinogens and/or mutagens(1-4). Therefore, the determination of PAH and $NO_2$-PAH in ambient and indoor air is of considerable importance to the characterization of air quality.

The objectives of this project were (a) to evaluate and test a generic sampling and analysis methodology to characterize PAH and $NO_2$-PAH concentrations in ambient and indoor air and (b) to identify sources responsible for variations in the PAH concentrations in air and estimate the quantitative importance of these sources.

A range-finding study was conducted to estimate the influence of the following parameters on the PAH concentrations in residences:

- smoking
- woodburning fireplaces
- home utilities (gas or electric)
- ambient air intrusion.

Eight study homes and two background homes located in Columbus, Ohio, were selected for sampling based on the presence or absence of cigarette smokers, woodburning fireplaces, and gas or electric utilities. For all the homes with fireplaces in use, the fireplaces were open/vented fireplaces. Samples were taken in each home over a 24-hr period. The indoor concentration measurements consisted of a series of three 8-hr samples taken at different locations within the home. Sampling was conducted according to the schedule in Table 1.1

TABLE 1.1. SAMPLING SCHEDULE

| Sampling Time | Location Within Home |
|---|---|
| 0700-1500 hr | Kitchen |
| 1500-2300 hr | Living area |
| 2300-0700 hr | Sleeping area |

A 24-hr ambient outdoor air sample was also collected at each residential site. The outdoor sample provided information on background levels for comparison with the indoor levels. Sampling took place during the winter heating season from March 12 to 27, 1984. A modified EPA medium volume sampler consisting of a quartz fiber filter to collect particulate matter and a polyurethane foam (PUF) cartridge to collect vapor was used.

Based on results of previous work(5-6), nineteen target compounds, representing three classes of PAHs, were chosen for the study. These compounds are presented in Table 1.2.

TABLE 1.2. TARGET COMPOUNDS

| Species | Class |
|---|---|
| Phenanthrene | PAH |
| Anthracene | PAH |
| Fluoranthene | PAH |
| Pyrene | PAH |
| Cyclopenta(c,d)pyrene | PAH |
| Benz(a)anthracene | PAH |
| Chrysene | PAH |
| Benzo(b)fluoranthene | PAH |
| Benzo(j)fluoranthene | PAH |
| Benzo(k)fluoranthene | PAH |
| Benzo(e)pyrene | PAH |
| Benzo(a)pyrene | PAH |
| Indeno(1,2,3-c,d)pyrene | PAH |
| Benzo(g,h,i)perylene | PAH |
| Coronene | PAH |
| 1-nitropyrene | Nitro-PAH |
| 2/3-nitrofluoranthene | Nitro-PAH |
| Quinoline | Nitrogen heterocycle |
| Isoquinoline | Nitrogen heterocycle |

The sample extracts were analyzed by positive-chemical-ionization gas chromatography/mass spectrometry (PCI GC/MS) to identify and quantify PAHs and nitrogen heterocycles; and negative-chemical-ionization gas chromatography/mass spectrometry (NCI GC/MS) to identify and quantify nitro-PAHs.

A statistical analysis was performed on the analytical data to interpret and to estimate the influence of the following parameters on the PAH concentrations in air within residences:

- cigarette smoking
- woodburning fireplaces
- time of day
- location within the residence
- home to home variation
- day to day variation
- nonsystematic variation
- gas versus electric utilities
- outside air infiltration.

In addition, passive dosimeters for PAH, based on room-temperature phosphorescence and developed by Oak Ridge National Laboratories (ORNL), were exposed at each sampling site, including both ambient and indoor air. The dosimeters were sent back to ORNL for analysis. A comparison of Battelle and ORNL results will be made by the EPA Project Officer to evaluate the utility of the passive dosimeters in comparison with active sampling procedures.

## SECTION 2

## CONCLUSIONS

The results of the preliminary study of the polyurethane foam (PUF) cartridges showed that background problems encountered in the analysis of polynuclear aromatic hydrocarbons collected on PUF from previous studies have been resolved by using a modified cleanup method that includes compression rinsing and Soxhlet extraction. The Soxhlet extraction method, which is currently being used in polychlorinated biphenyl (PCB) studies, has been successfully demonstrated to remove PAHs and their derivatives from PUF cartridges. Generally good recoveries were obtained for target compounds spiked onto the PUF cartridges prior to sampling, with the exception of some highly volatile compounds such as $D_8$-naphthalene, quinoline and isoquinoline, and a reactive PAH, cyclopenta(c,d)pyrene. Thus, using PUF cartridges as backup sorbent traps may not be sufficient to collect highly volatile PAHs. The possible losses of reactive PAHs such as cyclopenta(c,d)pyrene during sampling will require additional studies to resolve this problem.

The results of the statistical analyses indicated that cigarette smoking and the use of gas heat and appliances in the home increase the PAH concentrations in indoor air. The use of a woodburning fireplace did not appear to be as important as were the other two factors. Comparisons of the influences of sampling locations showed that the living room PAH levels were higher than the kitchen levels, which in turn were higher than the bedroom levels. The air exchange rates of homes were inversely related to the levels of PAHs in the air; however this relationship was statistically significant for only a few target compounds. Sources of variation not included in the statistical model constituted the largest single source of random variation. Home-to-home variation was second largest for most of the compounds, while day-to-day variation was the smallest.

The results of the statistical analyses provide information concerning factors that should be addressed in a full scale PAH study. The following factors were identified in the analysis:

- Cigarette smoking is a major factor affecting PAH levels. Therefore the presence or absence of smoking should be included as a stratification variable in the full scale design. Sample homes should include both those that have smokers and those that do not.
- The PAH levels are considerably higher in gas-heated homes than electrically heated ones. Since the primary interest of a full scale study is in homes with high PAH levels, the study should include mostly gas homes. Homes with electric heat should be included only as controls.
- Even though the presence of a woodburning fireplace did not seem to be a major factor for most compounds, it should still be included in a full scale study. Fireplace use was expected *a priori* to be an important factor, and was found to be significant for several of the compounds.
- The PAH concentrations can vary significantly depending on the location within a home. Therefore, the sampler location must be carefully considered in the full scale study.
- Home-to-home variations and day-to-day variations were similar in magnitude, with home-to-home variations somewhat larger. Therefore, the sample allocation in a full scale study should include more sampling of different homes and less repeat sampling at the same homes. However, the study should include some repeat sampling to assess accurately the magnitude of day-to-day variations.

Both 2-nitrofluoranthene (2-NF) and 1-nitropyrene (1-NP) were identified and quantified in the extracts of the indoor and outdoor air particulate samples. Levels of 2-NF were greater than levels of 1-NP for all the samples except for samples collected at home A. Similar results have been obtained in other studies conducted by Battelle (1,2), which showed that samples of ambient air particulate material contained levels of 2-NF equal to or greater than levels of 1-NP. In contrast, in these other studies, 1-NP has always been detected at higher levels than 2-NF in mobile source emission samples. The ambient air sample in this study that was heavily influenced by mobile source emissions also had levels of 1-NP greater than those of 2-NF. The higher levels of 1-NP found in the samples collected at home A may be explained by contamination from a mobile source during sampling. The differences in concentration of these two nitro-PAHs between mobile-source-emission and ambient-air particulate samples suggests that 2-NF is either more stable than 1-NP or is more easily formed through atmospheric transformation reactions than 1-NP. In one bacterial mutagenesis test strain, TA98-59, 2-NF has approximately the same mutagenic activity as 1-NP. Because of its higher concentration and its mutagenicity, 2-NF may be a more significant compound than 1-NP for monitoring in ambient air.

# SECTION 3

# RECOMMENDATIONS

Based on the results of this study, the following three recommendations can be made.

A polyurethane foam (PUF) cartridge was used to collect the vapor phase PAHs in this study. It was discovered that there was an interfering material that was removed from the PUF cartridge by cleanup using a compression method followed by Soxhlet extraction. Currently, Soxhlet extraction is used to remove PAHs from the PUF cartridge. If the compression method can be demonstrated to be comparable or superior to the Soxhlet extraction method, significant savings of time and expense can be achieved. Therefore a study should be conducted to evaluate the ability of the compression method to remove PAHs from PUF cartridges.

It was observed that after cleanup, the PUF cartridge changed from a pale white to a light yellow color over a one week storage period. It is not known whether this color change on storage is associated with any change in the PUF cartridge's ability to retain PAH material. In the pilot study, the PUF cartridges were cleaned the day before sampling and extracted within eight hours after sampling. However, if this sampling design is being considered for use in a large-scale air monitoring study, placement of the samplers in the field and return of the filters and PUF cartridges after sampling to analytical laboratories for extraction may take several weeks. Therefore it is recommended that a study be conducted to determine the stability of PUF cartridges for PAH measurement. In the stability study, the PAH levels collected on the PUF can be measured as a function of storage time between collection and extraction. The influence of storage time on the PAH measurements from the PUF cartridges can then be addressed.

A study conducted by Horning's group(7), indicated that levoglucosan, an anhydride of β-glucose, can be used as a distinctive marker for wood smoke. Recently, Battelle conducted a study(8) showing that levoglucosan was a major component of indoor air particulate samples resulting from open-fire woodburning. It is suggested that the use of levoglucosan as a wood smoke marker be investigated by analyzing selected sample extracts from this study, with and without woodburning fireplaces. It should be possible to establish a relationship between the levels of PAH resulting from woodburning fireplaces and the levels of levoglucosan.

# SECTION 4

# EXPERIMENTAL PROCEDURES

## SAMPLING METHODOLOGY

In this study, a modified EPA medium volume sampler having a quartz fiber filter and a polyurethane foam cartridge was used. Indoor air samples were taken over eight hours in each of three locations -- kitchen, living room, and sleeping area -- according to the following schedule.

| Sampling time | Location within Home |
|---|---|
| 0700-1500 hrs | Kitchen |
| 1500-2300 hrs | Living room |
| 2300-0700 hrs | Sleeping Area |

A 24-hr outdoor air sample at each residential site was also collected. The air exchange rate of each home was determined from the decreasing concentration of injected sulfur hexafluoride ($SF_6$) with time, as determined by gas chromatography/electron capture detection (GC/ECD). A summary of the sampling conditions for each home is given in Table 4.1. In addition, passive dosimeters for PAHs, developed by the Oak Ridge National Laboratories (ORNL), were used at each sampling site to sample both indoor and outdoor air. Dosimeters were sent back to ORNL for analysis.

### Sampling Module

A modified EPA medium volume sampler with a rotary carbon vane oil-less vacuum pump was used in the indoor air sampling. The particle filter holder and PUF cartridge were mounted in series on a tripod (sample inlet height 20 in) that could be fitted with leg extension pieces (sample inlet height 60 in). An aluminum "hat" was devised to avoid collection of debris on the

TABLE 4.1 SUMMARY OF SAMPLING

| Home Code | Sampling Date | Heating System | Smoking | Woodburning Fireplace in Use |
|---|---|---|---|---|
| A | 03/12/84 | Gas | No | No |
| B | 03/13/84 | Gas | No | Yes |
| C | 03/13/84 | Gas | No | Yes |
| D | 03/14/84 | Gas | Yes | Yes |
| E(a) | 03/19/84 | Gas | Yes | No |
| F | 03/19/84 | Gas | Yes | Yes |
| G(b) | 03/21/84 | Electric | No | No |
| H(b) | 03/21/84 | Electric | No | No |
| I | 03/23/84 | Gas | No | No |
| J | 03/27/84 | Gas | Yes | No |
| K(C2)(c) | 03/27/84 | Gas | No | Yes |
| L(F2)(d) | 03/27/84 | Gas | Yes | Yes |

(a) Home E had an electric range.
(b) Background homes.
(c) Home K is repeat of home C.
(d) Home L is repeat of home F.

particle filter. The pump unit was located outside the house in an insulated housing to minimize noise.

The tube connecting the sampling module to the pumping station was passed through an open window. The opening was then sealed with one-inch thick extruded polystyrene insulation (Styrofoam) and two-inch wide duct tape. A similar arrangement was used to allow the 220V AC power cable to the indoor air sampling pump and the 115V AC power cable to the outdoor air sampler to be passed through. Placement of the sampler pump for the indoor sampler was constrained by the necessity to minimize the length of both the sample line and the 220V AC power cable. Generally, the pump, housed in a sound-insulated weather-resistant wooden box, was placed near a window, allowing access to the central areas of the ground floor. The one-inch O.D. heavy-wall vinyl tubing sample line was secured along the baseboards with adhesive tape. The sampler tripod was situated in each sampling location as close as safely possible to the areas in the rooms that the residents usually occupied. In the kitchen, the sampling module was placed on a kitchen counter, and the tripod leg extensions were not used. The sample inlet was placed approximately one-two feet away from the stoves. During the kitchen sampling period, all the residents from the study homes and background homes cooked breakfast, and some of the residents also cooked lunch. As for the smoker-occupied homes, most of the smokers stayed in the room being sampled. Activity logs of each home are given in Appendix A.

An EPA medium volume sampler, incorporating a General Metals bypass motor in place of the original high volume motor, was used for ambient air sampling. The outdoor sampler was placed in the back yard of the study home in a location selected so that interferences from exhaust openings or flue vents from the house were avoided. The sampler was also placed to minimize noise.

## Sampling Procedure

The procedure for sampling was as follows. A clean PUF cartridge and a filter were placed in the sampler. The sampler pump was turned on and the flow was measured by means of a calibration head and U-tube manometer. Adjustments were made with a control and bypass valve located in the pump housing box. The setup for the outdoor sampler was the same. The participants had already been given a questionnaire and an activity record sheet. An injection of $SF_6$ was made, and the first sample was taken after one hour. Three or four clean, stoppered 50-cc syringes were given to the participant at this point for taking air samples every two hours during the first eight hours. The time at which each air sample was taken was written on a label provided on the syringe. Additional syringe samples were taken when the operators returned at the end of the first 8-hr period. The operator checked the flow rate, then stopped the sampling and moved the indoor sampler to the next location. The final visit occurred at the end of the third period. The sample apparatus was dismantled, and the participant activity record sheets were collected. At this time the 24-hr outdoor sampler was also given a final flow check. The PUF cartridges were wrapped with aluminum foil and placed in screw-capped jars. The filters were placed between watch glasses and sealed with Teflon tape, then wrapped with aluminum foil. These samples were sent to the laboratory for analysis.

### Air Exchange Rate Determination

Air samples in labelled 50-cc plastic syringes were stored as received at ambient temperature (ca. 26°C) until analyzed. Prior to each injection, the sample loop on a Varian 1200 gas chromatograph (GC) with an electron capture detector was purged with 50-cc of ultra-pure hydrocarbon-free air. Gas chromatographic parameters for analyses of sulfur hexafluoride ($SF_6$) in this study were:

Carrier Gas - Zero nitrogen with scrubber
Sample Flow Rate - 100 cc/min
Column Temperature - 40°C
Columns: Collection - Porapak Q; 1/4 in. O.D.; 3 ft length
Separation - Molecular Sieve 5A; 1/4 in. O.D.; 6 ft length

Ultra-pure air injections were used at the onset of each day's analyses to establish background parameters. A five milliliter sample loop was attached to the GC to initially screen samples for $SF_6$. Those samples with off-scale concentrations of $SF_6$ were reinjected either using a one milliliter sample loop or after sequential dilutions made with ultra-pure air in the plastic syringe. Every fourth sample injection was analyzed in duplicate. Valve and clean air injections were recorded periodically to check instrument performance and to ensure that no entrainment from inordinantly high concentrations of $SF_6$ was occurring from one injection to another.

## CHEMICAL ANALYSIS METHODOLOGY

### Polyurethane Foam Cartridge Cleanup

The first attempt to clean the PUF cartridge followed the PUF cleanup method used for polychlorinated biphenyls (PCB) (9). The PUF plug was extracted with 5% ether/hexane for a period of 16 hr. However, it was discovered that there was still an interfering material that was removed from the PUF plug during the Soxhlet extraction. This material is presumed to be a hydrocarbon impurity from the polymer matrix. Using only the Soxhlet extraction method to clean the PUF plug did not remove it. The background problem was eliminated, however, by using a modified cleanup method consisting of compression rinsing followed by Soxhlet extraction.

The PUF plug was placed in a beaker containing 800 ml of toluene and was compressed 20 times using the base of a 250-ml graduated cylinder. This procedure was repeated using acetone and 5% ether/hexane as solvents. Then the PUF plug was extracted with acetone for 16 hr and dried in a vacuum oven with water aspirator at room temperature. Following cleanup the PUF cartridge was wrapped with hexane-rinsed aluminum foil and was placed in a 32-ounce jar with a Teflon-lined cap until it was used. Typically, all the PUF cartridges were cleaned within 24 hr prior to sampling.

## Polynuclear Aromatic Hydrocarbon Recovery from Polyurethane Foam Cartridges

Two PUF cartridges were cleaned by the compression method followed by Soxhlet extraction and were spiked with 150 µl of a standard solution containing selected PAH, $NO_2$-PAH and nitrogen heterocyclic compounds at a nominal concentration of 18 µg/ml for each component (Table 4.2). The spiked PUF cartridges were Soxhlet-extracted with 5% ether/hexane for 16 hr. The extracts were then concentrated to 1 ml for chemical analysis to determine the recovery of the PAHs from the PUF. Prior to GC/MS analysis, an internal standard, 9-phenylanthracene, was added to the extract to give a concentration of 5 µg/ml.

In another study, three EPA medium volume samplers using General Metals bypass motors in place of the original high volume motors were employed. A quartz fiber filter and a backup PUF cartridge were used. The three samplers were placed in parallel and operated outdoors. Prior to sampling, two of the three PUF cartridges were spiked with 200 µl of the above standard solution. Air was sampled for eight hours at a nominal flow rate of 8 cfm. At the end of this time, the PUF cartridges were removed for chemical analysis.

TABLE 4.2. TARGET COMPOUNDS FOR THE PUF SPIKED RECOVERY STUDY

| Compound | Molecular Ion |
|---|---|
| $D_8$-Naphthalene | 136 |
| Quinoline | 129 |
| Isoquinoline | 129 |
| Phenanthrene | 178 |
| $D_{10}$-Phenanthrene | 188 |
| Fluoranthene | 202 |
| Pyrene | 202 |
| $D_{10}$-Pyrene | 212 |
| 1-Methylpyrene | 216 |
| Benz(a)anthracene | 228 |
| $D_{12}$-Chrysene | 240 |
| Cyclopenta(c,d)pyrene | 226 |
| 1-Nitropyrene | 247 |
| Benzo(e)pyrene | 252 |
| Benzo(a)pyrene | 252 |
| $D_{12}$-Benzo(a)pyrene | 264 |
| Benzo(g,h,i)perylene | 276 |
| Coronene | 300 |

The PUF cartridges were extracted with 5% ether/hexane for 16 hr and concentrated to 1 ml. The internal standard, 9-phenylanthracene, was added to each extract prior to the GC/MS analysis to give a concentration of 5 µg/ml.

Sample Preparation

Soluble organic material was removed from the filter and PUF cartridge by Soxhlet extraction with methylene chloride and 5% ether/hexane respectively. The extraction was carried out for at least 16 hr and until the solution in the Soxhlet extractor's top chamber became colorless. After extraction the sample extract was concentrated by Kuderna-Danish evaporation to a final volume of 1 ml. An aliquot was removed for gravimetric analysis. The residue was accurately weighed to the nearest ± 0.2 microgram on a Mettler Model ME30 microbalance, and this weight was used to determine the total extractable organic mass collected on the filter and the PUF.

### Selection of Target Compounds for Quantitative GC/MS Analysis

Target compounds selected for identification and quantification in the pilot study are listed in Table 4.3. The selection of target compounds was based on the results of previous work assignments (5,6) and recommendations from the EPA project officer.

### Sample Combination Matrix for GC/MS Analysis and Statistical Analysis

A total of 48 PUF and 48 filter samples were extracted in the study. Ideally, separate GC/MS analysis should be performed on the PUF and filter for each sample, but due to cost limitations only a few samples were analyzed this way. The majority of the filter and PUF extracts for a given sample were combined for a single analytical determination. A sample combination scheme was designed to reduce the number of GC/MS analyses, but not lose significant information for the statistical analysis. Tables 4.4 and 4.5 summarize this combination scheme.

Exactly one-half of each PUF and one-half of each filter extract were used for analysis of PAH and nitrogen heterocyclic compounds. The other half of each extract was reserved for bioassay. Because 1-NP and 2-NF were found only in the filter sample, one-fourth of the indoor filter sample extracts at three sampling locations were combined for $NO_2$-PAH analysis. In addition, selected PUF and filter combined samples were reanalyzed separately, to ensure that variations of the analytical method for the determinations of the combined samples and the individual samples were not significant.

### Analysis by Gas Chromatography/ Mass Spectrometry

Positive-chemical-ionization gas chromatography/mass spectrometry was used to determine the majority of the target compounds, including PAHs and nitrogen heterocyclic compounds. Because the levels of nitro-PAH in the air within a residence were expected to be very low, a more sensitive analytical method, negative-chemical-ionization gas chromatography/mass spectrometry was employed to determine the nitro-PAH.

## TABLE 4.3. TARGET COMPOUNDS

| Compound | Quantification Ion (m/z) | Biological Activity |  | Remarks |
|---|---|---|---|---|
|  |  | Short-Term Bioassay | Carcinogenic Activity |  |
| Quinoline | 129 | Active in TA100 | Sufficient | Quinoline is toxic to humans and is a major compound in coal combustion emissions and in cigarette smoke. |
| Isoquinoline | 129 | No evidence | No evidence | Isomer of quinoline. |
| Anthracene | 178 | No evidence | No evidence | This compound is not active, but can be a marker for volatile PAH. |
| Phenanthrene | 178 | No evidence | No evidence | This compound is not active, but can be a marker for volatile PAH. |
| Pyrene | 202 | Limited | No evidence | The nitro derivatives are strong mutagens; thus, pyrene may be a marker for total PAH and nitro-PAH levels. |
| Fluoranthene | 202 | Limited | No evidence | Fluoranthene is a marker for total PAH levels. It is chemically stable, usually found in moderate relative amounts, and has intermediate volatility. |
| Cyclopenta[c,d]pyrene | 226 | Sufficient | Limited | Cyclopenta[c,d]pyrene may be a marker for mobile source contamination. |

TABLE 4.3. (Continued)

| Compound | Quantification Ion (m/z) | Biological Activity |  | Remarks |
|---|---|---|---|---|
|  |  | Short-Term Bioassay | Carcinogenic Activity |  |
| Benz[*a*]anthracene | 228 | Sufficient | Sufficient | BaA is not only active, but also is a precursor for dimethylbenzanthracene, a potent carcinogen. |
| Chrysene | 228 | Limited | Limited | Chrysene is a weak mutagen and carcinogen. However, if a large amount of chrysene is found in some samples, then a detailed study for methylchrysene is recommended because some methylchrysenes are very active biologically. |
| Benzo[*b*]fluoranthene | 252 | Sufficient | Sufficient | Benzofluoranthenes are active compounds. Since they coelute, total amounts of all isomers would be reported in the results of GC/MS analysis. |
| Benzo[*j*]fluoranthene |  | Limited | Sufficient |  |
| Benzo[*k*]fluoranthene |  | Limited | Sufficient |  |
| Benzo[*e*]pyrene | 252 | Limited | Inadequate | Even though BeP has limited activity, BeP is more stable than BaP. BeP must be analyzed to certify data on its carcinogenic isomer BaP. Several researchers believe BeP derivatives are highly mutagenic. |

TABLE 4.3. (Continued)

| Compound | Quantification Ion (m/z) | Biological Activity | | Remarks |
|---|---|---|---|---|
| | | Short-Term Bioassay | Carcinogenic Activity | |
| Benzo[*a*]pyrene | 252 | Sufficient | Sufficient | Because much historical data on BaP concentrations is in the literature, BaP is an important compound to be studied. |
| Indeno[1,2,3-*c,d*]pyrene | 276 | Inadequate | Sufficient | Indeno[1,2,3-*c,d*]pyrene is a carcinogen and should be monitored. |
| Benzo[*g,h,i*]perylene | 276 | Inadequate | Inadequate | B[*g,h,i*]P is a weak carcinogen, but should be monitored to compare with other contamination sources (e.g., auto exhaust shows high levels of B[g,h,i]P). B[g,h,i]P is a persistent compound in ambient air samples. |
| Coronene | 300 | Limited | No evidence | Coronene is not very active, but may be a marker for mobile source contamination. |
| 1-nitropyrene | 247 | Sufficient | Limited data(4) | Both 1-NP and 2-NF are strong mutagens and should be monitored in air samples. |
| 2-nitrofluoranthene | 247 | Sufficient | Limited data(4) | |

TABLE 4.4. SAMPLE COMBINATION MATRIX OF BACKGROUND HOMES FOR GC/MS ANALYSIS

| PCI GC/MS | NCI GC/MS |
|---|---|
| Background Home | |
| Home G | |
| f1+P1[a] | f1+f2+f3 |
| f2+P2 | |
| f3+P3 | f4 |
| f4+P4 | |
| Home H | |
| f1+P1 | f1+f2+f3 |
| f2+P2 | |
| f3+P3 | f4 |
| f4+P4 | |

(a) f = Filter sample
p = PUF sample
1 = Kitchen area
2 = Living area
3 = Sleeping area
4 = Outdoor
f+P = Combine filter and PUF for analysis.
f,P = Analyze filter and PUF samples separately.

## TABLE 4.5 SAMPLE COMBINATION MATRIX OF STUDY HOMES FOR GC/MS ANALYSIS

| No Wood Burning Fireplace in Use | | | | Wood Burning Fireplace in Use | | | |
|---|---|---|---|---|---|---|---|
| PCI GC/MS | NCI GC/MS | PCI GC/MS | NCI GC/MS | PCI GC/MS | NCI GC/MS | PCI GC/MS | NCI GC/MS |
| No Smoking | | | | | | | |
| Home A | | Home I | | Home B | | Home C & C2 | |
| f1+P1(a) | f1+f2+f3 | f1,P1 | f1+f2+f3 | f1+P1 | f1+f3 | f1+P1 | f1+f2+f3 |
| f2+P2 and f2,P2 | | f2,P2 | | f2+P2 and f2,P2 | | f2+P2 | |
| f3+P3 | | f3,P3 | | f3+P3 | | f3+P3 | |
| f4+P4 | f4 | f4,P4 | f4 | f4+P4 | f4 | f4+P4 | f4 |
| Smoking | | | | | | | |
| Home E | | Home J | | Home D | | Home F & F2 | |
| f1+P1 | f1+f2+f3 | f1+P1 | f1+f2+f3 | f1,P1 | f1+f2+f3 | f1+P1 | f1+f2+f2 |
| f2+P2 | | f2+P2 and f2,P2 | | f2,P2 | f4 | f2+P2 | |
| f3+P3 | f4 | f3+P3 | f4 | f3,P3 | f4 | f3+P3 | f4 |
| f4+P4 | | f4+P4 | | f4,P4 | | f4+P4 | |

(a) f = Filter sample
p = PUF sample
1 = Kitchen area
2 = Living area
3 = Sleeping area
4 = Outdoor
f+P = Combine filter and PUF for analysis.
f,P = Analyze filter and PUF samples separately.

A Finnigan 4500 GC/MS was used for the GC/MS analysis. Methane was the carrier as well as the reagent gas. A bonded-phase fused silica capillary column, Ultra No. 2 crosslinked 5% phenylmethylsilicone, was used as both the GC column and the transfer line linking the GC oven and the MS ionization source. Data acquisition and processing were performed with a Finnigan/INCOS Model 2100 data system. The GC and MS operating conditions are listed in Table 4.6.

### Positive Chemical Ionization Gas Chromatography/Mass Spectrometry Method

Standard solutions containing the target compounds and the internal standard, 9-phenylanthracene, were prepared at three concentrations (5.0 µg/ml, 2.5 µg/ml, and 1.0 µg/ml). The internal standard was held at a fixed concentration of 5.0 µg/ml. These standard solutions were analyzed by on-column injection PCI GC/MS in the multiple ion detection (MID) mode to generate calibration curves.

Ion peaks monitored by the mass spectrometer were the protonated molecular ion peaks of the compounds of interest. Identifications of the target compounds in the sample extracts were based on the correct molecular ions and the correct retention times relative to the internal standard, as determined from the standard analyses. Full scan analyses of three samples were performed and were used for confirmation of identification. From the standard analyses, the response factor for each compound relative to the internal standard was calculated over the calibration range. The following equation shows the factors on which quantification was based:

$$C_x(\mu g) = \frac{A_x \times C_{is} \times FV}{A_{is} \times R_f}$$

where

$C_x$ = total µg of a target compound found in the extract

$A_x$ = area of the molecular ion peak of a target compound in the reconstructed chromatogram

$C_{is}$ = concentration of the internal standard in µg/ml = 5 µg/ml

$A_{is}$ = area of the molecular ion peak of the internal standard in the reconstructed chromatogram

## TABLE 4.6 GC AND MS OPERATING CONDITIONS

| | |
|---|---|
| **Chromatography** | |
| Column: | HP Ultra No. 2 crosslinked 5% phenyl methyl silicone 50 m x 0.31 mm, 0.17 µm film thickness |
| Carrier: | methane |
| Carrier linear flow velocity: | 50 cm/sec at 250°C |
| Injection volume: | 1 µl |
| Injection mode: | on-column |
| **Temperature Program** | |
| Initial column temperature: | 45°C |
| Initial hold time: | 2 min |
| Program rate: | 100°C (5 min) to 320°C at 6°C/min(1) or at 10°C/min(2) |
| Final hold time: | 10 min |
| **Mass Spectrometer** | |
| Ionization: | PCI at 150 ev or NCI at 200 ev |
| Filament emission current: | 0.3 ma |
| Preamplifier: | $10^{-8}$ amp/volt |
| Electron multiplier gain: | $10^5$ gain |

(1) Used for the PCI GC/MS method.

(2) Used for the NCI GC/MS method.

$R_f$ = response factor of a target compound
FV = final volume of a sample extract in ml.

### Negative Chemical Ionization, Gas Chromatography/Mass Spectrometry Method

The identification and quantification of $NO_2$-PAH were accomplished using an on-column injection, NCI GC/MS technique in the MID mode. Quantification was performed using response factors from the analysis of a calibration standard containing 1-nitropyrene at three concentration levels (0.1 µg/ml, 0.01 µg/ml, and 0.001 µg/ml). Previous work (1,2) has shown that 3-nitrofluoranthene and 1-nitropyrene have identical response factors for NCI detection. A standard containing two nitro-PAHs (1-NF and 3-NF) was used to determine GC relative retention times for confirmation of compound identifications. The internal standard, $D_9$-1-nitropyrene, was added to the standard solutions and to each sample extract at a final concentration of 0.01 µg/ml. The identification and quantification method has been discussed in detail in the section above on the PCI GC/MS method. Full scan analyses of three samples were conducted to confirm the identification of $NO_2$-PAHs.

Recently, 2-nitrofluoranthene standard compound was synthesized for another study. The results showed that 2-NF and 3-NF have the same response factors for NCI detection and have the same relative retention times for the internal standard under the GC conditions used. However, 2-NF and 3-NF can be separated under a slower GC temperature program rate. All the sample extracts were reanalyzed under these revised GC conditions to determine which nitrofluoranthene isomers are present in the sample extracts.

## STATISTICAL ANALYSIS METHODOLOGY

The data for this pilot study were collected under a variety of experimental conditions, for example, in the presence or absence of smoking, or with a fireplace in use or not in use. To understand and interpret these data more fully, a comprehensive statistical analysis was conducted. The use of a statistical approach provided the necessary structure and interpretative technique to allow inferences to be made concerning the influence of the experimental factors on the concentrations of the target compounds.

The analyses involved the generation of summary statistics, for example means and standard deviations, as well as statistical modeling to assess the separate influence of the individual experimental factors. The analyses were performed separately on each of the 17 target compounds addressed in the study. This report presents, in detail, the results of the statistical analyses on two of the most important compounds. Similar results are given in the appendices for the remaining compounds.

## Data

The sampling protocol required that a PUF cartridge trap and filter be used to collect the target compounds in both the vapor and particulate forms. However, due to cost limitations, the majority of filter and PUF samples were combined prior to GC/MS analysis according to the sample combination scheme shown in Tables 4.4 and 4.5.

For the purposes of statistical analysis, corresponding separate filter and PUF cartridge analytical results were summed to obtain a single concentration. The summed values were then considered to be comparable to values obtained from the combined extract for the PUF cartridge trap and filter.

## Auxiliary Data

Various auxiliary data were also collected. These data provided information for the interpretation and understanding of the pollutant data. The auxiliary information included an estimate of the air exchange rate for each home during its sampling period, and included results obtained from the questionnaire completed for each home. The determination of air exchange rate values for the different homes was described earlier. The air exchange rate was used as a covariate in the modeling effort in an attempt to adjust for differences in air-tightness across the sample homes. The questionnaire data were not directly used in the formal statistical analyses. Rather, these data were used to help interpret any unusual observed target compound values.

## Modeling

Statistical modeling of environmental pollutants generally involves the assumption of a multiplicative model for expressing the target compound concentration as a function of the effects of the experimental factors. These models are then analyzed by taking logarithms and expressing the log-concentrations as an additive function of the effects of the experimental factors. This requires the results of the modeling effort to be transformed back to the original units (non-log units). The interpretation of results on a log basis is generally complicated and requires careful interpretation.

The log model and non-log model were both considered initially. The observed data for several of the most important compounds were each fitted separately to the two types of models. The results indicated that the log model fitted the observed data somewhat better than the non-log model. However, in most cases the differences did not significantly affect the results. Therefore, because of the complications and interpretation difficulties inherent in the use of a log model, it was decided that a log model was not appropriate for this study. The non-log model results are therefore presented here. However, in those instances where the two models indicate significantly different results, the results of the log model are also presented.

# SECTION 5

# RESULTS AND DISCUSSION

## RECOVERY OF POLYNUCLEAR AROMATIC HYDROCARBONS AND THEIR DERIVATIVES FROM POLYURETHANE FOAM CARTRIDGES

An experiment was conducted to evaluate the extraction efficiencies of PAHs from PUF cartridges. The standard solution containing compounds of interest was spiked onto the PUF cartridge. The PUF cartridge was Soxhlet-extracted with 5% ether in hexane, and was analyzed by GC/MS. The recovery data from this study are presented in Table 5.1. The average recovery of the spiked compounds ranged from 77% to 116%. The recoveries of some of the compounds, for example, phenanthrene, pyrene, and isoquinoline are over 100%. This probably is due to the background levels of these compounds in the PUF cartridges. The relatively low recovery (77%) of the volatile compound, $D_8$-naphthalene, may be due to losses in the concentration step. Generally good recoveries of the compounds spiked onto the PUF cartridges were achieved. These results indicate that PAHs and their derivatives can be removed from PUF by using Soxhlet extraction with 5% ether/hexane.

In the breakthrough study of the PUF cartridge, the PUF cartridges were spiked with the compounds of interest and then exposed to about 100 $m^3$ of ambient air. Data from this study are shown in Table 5.2. Overall recoveries greater than 80% were achieved for compounds less volatile than quinoline, with the exception of cyclopenta(c,d)pyrene. The loss of $D_8$-naphthalene, quinoline, and isoquinoline was anticipated since these compounds are highly volatile. The ambient temperature during this experiment was -10 to $0^oC$, and greater losses of these compounds would be expected under summertime sampling conditions. The low recovery (56 to 69 percent) for cyclopenta(c,d)pyrene was probably due to chemical reactions,

## TABLE 5.1. RECOVERY OF PAHS AND THEIR DERIVATIVES FROM PUF CARTRIDGES THROUGH SOXHLET EXTRACTION

| Compound | Recovery, percent |  | Average |
|---|---|---|---|
|  | No. 1 | No. 2 |  |
| $D_8$-Naphthalene | 74 | 79 | 77 |
| Quinoline | 89 | 82 | 86 |
| Isoquinoline | 110 | 101 | 106 |
| Phenanthrene | 107 | 124 | 116 |
| $D_{10}$-phenanthrene | 100 | 98 | 99 |
| Fluoranthene | 99 | 102 | 101 |
| Pyrene | 106 | 109 | 108 |
| $D_{10}$-pyrene | 100 | 99 | 100 |
| 1-Methylpyrene | 98 | 101 | 100 |
| Benz(a)anthracene | 99 | 100 | 100 |
| $D_{12}$-Chrysene | 101 | 99 | 100 |
| Cyclopenta(c,d)pyrene | 99 | 100 | 100 |
| 1-Nitropyrene | 84 | 86 | 85 |
| Benzo(e)pyrene | 99 | 100 | 100 |
| Benzo(a)pyrene | 98 | 99 | 99 |
| $D_{12}$-Benzo(a)pyrene | 100 | 99 | 100 |
| Benzo(g,h,i)perylene | 99 | 100 | 100 |
| Coronene | 100 | 95 | 98 |

## TABLE 5.2. RECOVERY OF PAHS AND THEIR DERIVATIVES FROM PUF CARTRIDGES SPIKED PRIOR TO SAMPLING

| Compound | Nonspiked Cartridge, ng/$m^3$ | Spiked Cartridges Recovery, percent | | |
|---|---|---|---|---|
| | | No. 1 | No. 2 | Average |
| $D_8$-Naphthalene | --(a) | 11 | 15 | 13 |
| Quinoline | 0.12 | 24 | 50 | 37 |
| Isoquinoline | 0.31 | 25 | 75 | 50 |
| Phenanthrene | 31.4 | 100 | 76 | 88 |
| $D_{10}$-Phenanthrene | -- | 104 | 107 | 106 |
| Fluoranthene | 8.4 | 104 | 104 | 104 |
| Pyrene | 8.0 | 104 | 120 | 112 |
| $D_{10}$-Pyrene | -- | 105 | 106 | 106 |
| 1-Methylpyrene | 0.43 | 95 | 84 | 90 |
| Benz(a)anthracene | 0.08 | 102 | 140 | 121 |
| $D_{12}$-Chrysene | -- | 106 | 110 | 108 |
| Cyclopenta(c,d)pyrene | -- | 56 | 69 | 63 |
| 1-Nitropyrene | -- | 88 | 100 | 94 |
| Benzo(e)pyrene | 0.27 | 99 | 116 | 108 |
| Benzo(a)pyrene | -- | 92 | 118 | 105 |
| $D_{12}$-Benzo(a)pyrene | -- | 97 | 110 | 104 |
| Benzo(g,h,i)perylene | -- | 100 | 108 | 104 |
| Coronene | -- | 82 | 100 | 91 |

(a) The compound was not found in the sample.

since the five-member ring is highly susceptible to oxidation. In general, good recoveries were obtained for a wide variety of PAHs from the PUF cartridges after exposure to 100 $m^3$ of air. However, losses of volatile and reactive PAHs such as quinoline and cyclopenta(c,d)pyrene must be considered when evaluating data collected by using this sampling methodology.

## GRAVIMETRIC ANALYSIS OF THE SAMPLES

The total extractable organic material obtained in each sample is given in Table 5.3. The particulate weights of the filter samples are given in Table 5.4.

Relatively higher levels of extractable organic material were found on the PUF than that on the filters, except for five highly loaded filter samples. These highly loaded filter samples were collected in either kitchen or living room locations. Four of these five samples were collected from homes in which cigarettes were smoked, and only one from a home which had a wood-burning fireplace in use. For example, in home J, during kitchen and living room sampling, a total of 58 cigarettes were smoked. It is known that cigarette smoking contributes to higher levels of air particulate matter collected on filters, and it is not surprising that it contributes here to the particle loads and the higher levels of extractable organic matter found in these samples. The remaining highly loaded filter was collected in the kitchen area of home I, which had no smokers present and in which the wood-burning fireplace was not in use. However, the residents placed the sampling module just above the stove top when they were frying bacon for breakfast. This may have increased the levels of air particulate matter as well as the levels of extractable organic material.

In interpretation of the data for individual homes given in this report, it should be noted that the indoor samples were 8-hr samples, with a nominal volume of 100 $m^3$, and the outdoor samples were 24-hr samples, with a nominal volume of 300 $m^3$. Exact sampling volumes are given in Appendix B.

## TABLE 5.3. EXTRACTABLE ORGANIC MATERIAL OBTAINED FROM THE PUF AND FILTER SAMPLES

| Home Code | Total Extractable Organic Mass, mg | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Kitchen[a] | | Living Room[a] | | Sleeping Area[a] | | Outdoor[b] | |
| | Filter | PUF | Filter | PUF | Filter | PUF | Filter | PUF |
| A | 0.97 | 2.57 | 2.00 | 3.69 | 1.08 | 3.45 | 2.40 | 1.94 |
| B | 3.24 | 4.14 | 1.41 | 3.37 | 0.75 | 3.81 | 2.42 | 7.64 |
| C | 1.19 | 5.51 | 4.44 | 5.89 | 1.97 | 5.20 | 8.73 | 4.53 |
| D | 18.64 | 7.48 | 6.33 | 5.17 | 4.41 | 5.17 | 2.97 | 8.38 |
| E | 3.14 | 5.52 | 20.21 | 7.83 | 5.55 | 5.64 | 1.49 | 2.50 |
| F | 1.58 | 3.91 | 3.12 | 4.86 | 2.18 | 5.25 | 1.68 | 5.85 |
| G | 0.40 | 3.62 | 0.96 | 3.53 | 0.99 | 2.15 | 0.38 | 4.02 |
| H | 1.50 | 5.61 | 1.65 | 5.98 | 1.07 | 5.18 | 0.38 | 2.06 |
| I | 25.76 | 6.54 | 1.08 | 8.71 | 1.73 | 2.31 | 4.22 | 10.08 |
| J | 28.93 | 5.15 | 24.84 | 8.64 | 3.44 | 7.56 | 5.76 | 4.63 |
| K(C2) | 0.95 | 4.64 | 0.83 | 6.27 | 0.67 | 5.50 | 1.35 | 1.41 |
| L(F2) | 5.14 | 6.27 | 3.65 | 4.55 | 2.11 | 4.65 | 1.62 | 4.03 |

(a) Approximately 100 $m^3$ air sampled.
(b) Approximately 300 $m^3$ air sampled.

## TABLE 5.4. WEIGHTS OF PARTICULATE MATERIAL COLLECTED ON THE FILTERS

| Home Code | Particulate Weights, mg | | | |
|---|---|---|---|---|
| | Kitchen(a) | Living Room(a) | Sleep Area(a) | Outdoor(b) |
| A | 2.20 | 6.07 | 4.01 | 21.78 |
| B | 3.26 | 5.34 | 3.05 | 15.89 |
| C | 5.90 | 9.15 | 2.83 | 22.69 |
| D | 20.81 | 10.87 | 22.12 | 22.35 |
| E | 5.46 | 15.24 | 7.20 | 17.70 |
| F | 4.66 | 10.06 | 4.72 | 16.78 |
| G | 1.26 | 3.83 | 1.95 | 3.02 |
| H | 1.56 | 5.99 | 2.76 | 3.86 |
| I | 38.68 | 6.10 | 3.39 | 17.00 |
| J | 33.18 | 26.99 | 5.78 | 19.27 |
| K(C2) | 2.94 | 3.27 | 2.72 | 15.70 |
| L(F2) | 7.76 | 5.99 | 4.72 | 15.38 |

(a) Approximately 100 $m^3$ air sampled.
(b) Approximately 300 $m^3$ air sampled.

The same trend was observed for the outdoor ambient air samples: higher levels of extractable organic matter were found in the PUF samples than the filter samples, except for the sample collected from home C.

Because quartz fiber filters are very fragile, the edges of some filter samples were broken after sampling. Therefore, the particulate weights listed in Table 5.4 may be somewhat low. In one filter sample, that collected at home E, living area, the measured particulate weight was about 5 mg less than the extractable organic mass. This may be due to an inaccurate determination of the particulate weights for this filter sample.

## GAS CHROMATOGRAPHY/MASS SPECTROMETRY ANALYSIS

The PUF and filter samples were analyzed using PCI GC/MS with on-column injection for the identification and quantification of quinoline, isoquinoline, and PAH. The NCI GC/MS with on-column injection method was used for the determination of nitro-PAH. The GC/MS data are summarized in Table 5.5 through Table 5.17. The data presented in Tables 5.5 to 5.17 are the combined values from the filter and PUF samples; for those samples for which the filter and PUF extracts were analyzed separately, the summed values of both analyses are reported. The data for the PUF and filter blanks are summarized in Appendix C.

Data for the filter and PUF extracts analyzed separately indicate that the distribution of PAHs between filters and PUF cartridges agrees with the volatility of the compounds. Compounds having three rings, such as phenanthrene, were captured $\geq$90% on the PUF cartridge whereas those having five rings were captured $\geq$90% on the filter. The four-ring compounds, fluoranthene and pyrene, were found predominantly ($\geq$80%) on the PUF cartridge.

## TABLE 5.5. PAH CONCENTRATIONS IN AIR SAMPLED FROM STUDY HOME A

| Compound | Concentration - ng/m$^3$ Kitchen | Living Room | Bedroom | Outdoor |
|---|---|---|---|---|
| Quinoline | 1.02 | 1.34 | 1.14 | 0.21 |
| Isoquinoline | 0.87 | 1.02 | 0.90 | 0.18 |
| Phenanthrene | 49.25 | 72.02 | 58.99 | 35.44 |
| Anthracene | 2.67 | 3.67 | 2.31 | 4.20 |
| Fluoranthene | 13.00 | 22.54 | 12.06 | 18.35 |
| Pyrene | 6.18 | 11.17 | 5.28 | 13.11 |
| Cyclopenta(c,d)pyrene | 0.69 | 0.52 | 0.65 | 3.74 |
| Benz(a)anthracene | 0.69 | 0.67 | 0.55 | 2.69 |
| Chrysene | 1.37 | 1.42 | 0.92 | 3.92 |
| Benzofluoranthenes | 1.75 | 1.82 | 0.93 | 4.91 |
| Benzo(e)pyrene | 1.03 | 0.98 | 0.73 | 2.88 |
| Benzo(a)pyrene | 0.94 | 1.07 | 0.76 | 2.85 |
| Indeno(1,2,3-c,d)pyrene | 0.89 | 0.83 | 0.68 | 2.47 |
| Benzo(g,h,i)perylene | 1.75 | 1.40 | 1.41 | 5.10 |
| Coronene | 1.67 | 1.00 | 1.22 | 3.60 |

TABLE 5.6. PAH CONCENTRATIONS IN AIR SAMPLED FROM STUDY HOME B

| | Concentration - ng/m$^3$ | | | |
|---|---|---|---|---|
| Compound | Kitchen | Living Room | Bedroom | Outdoor |
| Quinoline | 1.51 | 1.63 | 2.60 | 0.28 |
| Isoquinoline | 1.20 | 1.27 | 2.08 | 0.15 |
| Phenanthrene | 77.23 | 88.52 | 54.61 | 36.29 |
| Anthracene | 4.70 | 5.81 | 3.06 | 3.62 |
| Fluoranthene | 22.64 | 25.17 | 18.31 | 11.95 |
| Pyrene | 10.48 | 10.38 | 7.25 | 6.90 |
| Cyclopenta(c,d)pyrene | 0.41 | 0.18 | 0.10 | 0.17 |
| Benz(a)anthracene | 0.75 | 0.64 | 0.46 | 0.90 |
| Chrysene | 1.42 | 1.21 | 0.92 | 1.98 |
| Benzofluoranthenes | 1.74 | 1.21 | 0.94 | 2.25 |
| Benzo(e)pyrene | 0.99 | 1.03 | 0.54 | 1.16 |
| Benzo(a)pyrene | 0.97 | 0.67 | 0.54 | 0.73 |
| Indeno(1,2,3-c,d)pyrene | 0.81 | 0.48 | 0.48 | 0.89 |
| Benzo(g,h,i)perylene | 1.40 | 0.82 | 0.72 | 1.62 |
| Coronene | 0.99 | 0.30 | 0.36 | 1.03 |

TABLE 5.7. PAH CONCENTRATIONS IN AIR SAMPLED FROM STUDY HOME C

| | Concentration - ng/$m^3$ | | | |
|---|---|---|---|---|
| Compound | Kitchen | Living Room | Bedroom | Outdoor |
| Quinoline | 1.36 | 1.50 | 1.37 | 0.11 |
| Isoquinoline | 0.79 | 0.95 | 0.91 | 0.17 |
| Phenanthrene | 58.42 | 68.11 | 67.44 | 32.40 |
| Anthracene | 2.74 | 2.55 | 2.70 | 1.43 |
| Fluoranthene | 16.22 | 18.36 | 18.20 | 12.09 |
| Pyrene | 7.93 | 7.70 | 8.23 | 5.84 |
| Cyclopenta(c,d)pyrene | 0.30 | 0.22 | 0.30 | 0.10 |
| Benz(a)anthracene | 0.44 | 0.46 | 0.38 | 0.67 |
| Chrysene | 1.09 | 1.23 | 0.95 | 1.88 |
| Benzofluoranthenes | 1.04 | 1.31 | 1.09 | 2.09 |
| Benzo(e)pyrene | 0.81 | 0.75 | 0.79 | 1.09 |
| Benzo(a)pyrene | 0.69 | 0.55 | 0.42 | 0.63 |
| Indeno(1,2,3-c,d)pyrene | 0.72 | 0.61 | 0.61 | 0.93 |
| Benzo(g,h,i)perylene | 1.02 | 0.89 | 0.83 | 1.33 |
| Coronene | 0.58 | 0.36 | 0.59 | 0.96 |

## TABLE 5.8. PAH CONCENTRATIONS IN AIR SAMPLED FROM STUDY HOME C2

| | Concentration - ng/m$^3$ | | | |
|---|---|---|---|---|
| Compound | Kitchen | Living Room | Bedroom | Outdoor |
| Quinoline | 0.29 | 2.82 | 1.55 | 0.18 |
| Isoquinoline | 0.69 | 1.73 | 0.94 | 0.17 |
| Phenanthrene | 55.16 | 62.49 | 58.38 | 26.57 |
| Anthracene | 2.14 | 2.50 | 2.27 | 1.20 |
| Fluoranthene | 12.98 | 19.67 | 13.65 | 12.31 |
| Pyrene | 5.67 | 7.28 | 5.81 | 6.13 |
| Cyclopenta(c,d)pyrene | 0.00 | 0.15 | 0.18 | 0.58 |
| Benz(a)anthracene | 1.03 | 0.69 | 0.45 | 1.07 |
| Chrysene | 1.26 | 1.60 | 1.02 | 2.14 |
| Benzofluoranthenes | 1.47 | 1.75 | 1.08 | 2.93 |
| Benzo(e)pyrene | 0.88 | 0.84 | 1.08 | 1.38 |
| Benzo(a)pyrene | 0.94 | 0.67 | 0.51 | 1.24 |
| Indeno(1,2,3-c,d)pyrene | 0.59 | 0.72 | 0.49 | 1.09 |
| Benzo(g,h,i)perylene | 0.98 | 0.97 | 0.72 | 1.69 |
| Coronene | 0.69 | 0.67 | 0.49 | 0.91 |

TABLE 5.9. PAH CONCENTRATIONS IN AIR SAMPLED FROM STUDY HOME D

| Compound | Concentration - ng/m$^3$ Kitchen | Living Room | Bedroom | Outdoor |
|---|---|---|---|---|
| Quinoline | 11.09 | 6.26 | 6.75 | 0.88 |
| Isoquinoline | 4.77 | 3.36 | 3.35 | 1.14 |
| Phenanthrene | 143.58 | 124.58 | 116.81 | 75.13 |
| Anthracene | 13.25 | 10.52 | 7.77 | 6.41 |
| Fluoranthene | 26.37 | 26.11 | 21.41 | 20.71 |
| Pyrene | 13.25 | 13.55 | 10.86 | 13.00 |
| Cyclopenta(c,d)pyrene | 1.72 | 1.11 | 0.28 | 0.64 |
| Benz(a)anthracene | 2.77 | 1.47 | 0.98 | 1.82 |
| Chrysene | 4.58 | 3.11 | 1.72 | 2.89 |
| Benzofluoranthenes | 3.39 | 2.52 | 1.26 | 3.41 |
| Benzo(e)pyrene | 2.24 | 1.31 | 0.72 | 2.05 |
| Benzo(a)pyrene | 2.65 | 1.56 | 0.74 | 1.94 |
| Indeno(1,2,3-c,d)pyrene | 2.60 | 1.21 | 0.83 | 1.65 |
| Benzo(g,h,i)perylene | 3.15 | 1.88 | 1.06 | 3.82 |
| Coronene | 1.94 | 1.19 | 0.82 | 2.39 |

## TABLE 5.10. PAH CONCENTRATIONS IN AIR SAMPLED FROM STUDY HOME E

| Compound | Concentration - ng/m$^3$ | | | |
|---|---|---|---|---|
| | Kitchen | Living Room | Bedroom | Outdoor |
| Quinoline | 10.40 | 37.40 | 11.40 | 0.83 |
| Isoquinoline | 40.71 | 23.50 | 63.18 | 0.67 |
| Phenanthrene | 60.61 | 70.97 | 75.61 | 31.17 |
| Anthracene | 3.78 | 8.15 | 7.50 | 2.21 |
| Fluoranthene | 14.31 | 18.56 | 17.99 | 14.32 |
| Pyrene | 5.46 | 7.96 | 7.01 | 7.88 |
| Cyclopenta(c,d)pyrene | 0.34 | 1.52 | 0.49 | 0.38 |
| Benz(a)anthracene | 0.74 | 2.18 | 1.01 | 1.41 |
| Chrysene | 1.45 | 4.65 | 2.03 | 2.76 |
| Benzofluoranthenes | 1.64 | 3.97 | 2.41 | 3.60 |
| Benzo(e)pyrene | 1.25 | 2.18 | 1.41 | 2.30 |
| Benzo(a)pyrene | 0.93 | 2.70 | 1.46 | 1.62 |
| Indeno(1,2,3-c,d)pyrene | 1.36 | 3.00 | 1.58 | 1.52 |
| Benzo(g,h,i)perylene | 1.98 | 2.41 | 1.94 | 2.74 |
| Coronene | 2.08 | 1.10 | 0.09 | 1.54 |

TABLE 5.11. PAH CONCENTRATIONS IN AIR SAMPLED FROM STUDY HOME F

| Compound | Concentration - ng/$m^3$ | | | |
|---|---|---|---|---|
| | Kitchen | Living Room | Bedroom | Outdoor |
| Quinoline | 8.09 | 31.23 | 4.10 | 0.45 |
| Isoquinoline | 4.41 | 13.63 | 13.17 | 1.54 |
| Phenanthrene | 112.49 | 132.33 | 103.11 | 46.09 |
| Anthracene | 5.01 | 8.12 | 4.35 | 3.28 |
| Fluoranthene | 24.28 | 37.37 | 22.11 | 16.90 |
| Pyrene | 10.74 | 18.10 | 10.09 | 9.07 |
| Cyclopenta(c,d)pyrene | 0.52 | 0.35 | 0.00 | 0.55 |
| Benz(a)anthracene | 1.01 | 2.25 | 0.73 | 1.11 |
| Chrysene | 1.98 | 5.25 | 1.77 | 2.53 |
| Benzofluoranthenes | 2.69 | 5.83 | 1.68 | 3.37 |
| Benzo(e)pyrene | 1.92 | 3.12 | 1.00 | 1.85 |
| Benzo(a)pyrene | 1.57 | 3.33 | 0.73 | 1.70 |
| Indeno(1,2,3-c,d)pyrene | 1.18 | 2.58 | 0.81 | 1.07 |
| Benzo(g,h,i)perylene | 2.75 | 2.77 | 0.95 | 2.49 |
| Coronene | 3.08 | 0.91 | 0.30 | 1.26 |

## TABLE 5.12. PAH CONCENTRATIONS IN AIR SAMPLED FROM STUDY HOME F2

| Compound | Concentration - ng/$m^3$ Kitchen | Living Room | Bedroom | Outdoor |
|---|---|---|---|---|
| Quinoline | 13.78 | 6.70 | 7.72 | 0.27 |
| Isoquinoline | 4.46 | 3.09 | 5.03 | 1.75 |
| Phenanthrene | 107.90 | 114.88 | 108.51 | 37.55 |
| Anthracene | 5.95 | 5.82 | 6.23 | 2.10 |
| Fluoranthene | 23.09 | 27.61 | 22.66 | 13.74 |
| Pyrene | 10.43 | 11.72 | 9.79 | 7.28 |
| Cyclopenta(c,d)pyrene | 0.56 | 0.37 | 0.29 | 0.23 |
| Benz(a)anthracene | 1.23 | 1.25 | 0.76 | 1.12 |
| Chrysene | 2.35 | 2.48 | 1.76 | 2.43 |
| Benzofluoranthenes | 1.51 | 2.95 | 1.57 | 3.00 |
| Benzo(e)pyrene | 0.90 | 1.56 | 0.88 | 1.59 |
| Benzo(a)pyrene | 0.96 | 0.90 | 1.07 | 1.17 |
| Indeno(1,2,3-c,d)pyrene | 1.13 | 1.21 | 0.99 | 1.07 |
| Benzo(g,h,i)perylene | 1.35 | 1.50 | 1.01 | 1.72 |
| Coronene | 0.92 | 0.90 | 0.63 | 0.85 |

## TABLE 5.13. PAH CONCENTRATIONS IN AIR SAMPLED FROM STUDY HOME G

| Compound | Concentration - ng/m$^3$ | | | |
|---|---|---|---|---|
| | Kitchen | Living Room | Bedroom | Outdoor |
| Quinoline | 4.50 | 0.51 | 0.78 | 1.62 |
| Isoquinoline | 0.66 | 0.94 | 2.19 | 1.19 |
| Phenanthrene | 41.63 | 50.94 | 50.28 | 33.84 |
| Anthracene | 2.87 | 2.73 | 3.39 | 1.36 |
| Fluoranthene | 9.77 | 14.79 | 13.39 | 10.64 |
| Pyrene | 4.79 | 5.90 | 5.52 | 4.89 |
| Cyclopenta(c,d)pyrene | 0.33 | 0.22 | 0.00 | 0.15 |
| Benz(a)anthracene | 0.26 | 0.81 | 0.00 | 0.23 |
| Chrysene | 0.57 | 0.94 | 0.59 | 0.97 |
| Benzofluoranthenes | 0.18 | 0.59 | 0.00 | 1.10 |
| Benzo(e)pyrene | 0.00 | 0.31 | 0.00 | 0.74 |
| Benzo(a)pyrene | 0.00 | 0.00 | 0.00 | 0.00 |
| Indeno(1,2,3-c,d)pyrene | 0.00 | 0.49 | 0.00 | 0.37 |
| Benzo(g,h,i)perylene | 0.00 | 0.45 | 0.00 | 0.64 |
| Coronene | 0.00 | 0.00 | 0.00 | 0.40 |

TABLE 5.14. PAH CONCENTRATIONS IN AIR SAMPLED FROM STUDY HOME H

| Compound | Concentration - ng/m$^3$ | | | |
|---|---|---|---|---|
| | Kitchen | Living Room | Bedroom | Outdoor |
| Quinoline | 1.22 | 1.18 | 0.33 | 0.51 |
| Isoquinoline | 0.57 | 0.52 | 0.85 | 0.42 |
| Phenanthrene | 34.54 | 33.77 | 24.13 | 10.10 |
| Anthracene | 1.48 | 1.48 | 1.32 | 0.58 |
| Fluoranthene | 9.23 | 9.94 | 5.11 | 4.75 |
| Pyrene | 5.15 | 4.30 | 2.67 | 2.54 |
| Cyclopenta(c,d)pyrene | 0.00 | 0.00 | 0.00 | 0.07 |
| Benz(a)anthracene | 0.30 | 0.31 | 0.19 | 0.23 |
| Chrysene | 0.61 | 0.68 | 0.41 | 0.50 |
| Benzofluoranthenes | 0.55 | 0.61 | 0.25 | 0.35 |
| Benzo(e)pyrene | 0.24 | 0.35 | 0.19 | 0.29 |
| Benzo(a)pyrene | 0.00 | 0.28 | 0.25 | 0.20 |
| Indeno(1,2,3-c,d)pyrene | 0.16 | 0.30 | 0.00 | 0.18 |
| Benzo(g,h,i)perylene | 0.49 | 0.48 | 0.27 | 0.29 |
| Coronene | 0.22 | 0.28 | 0.23 | 0.22 |

TABLE 5.15. PAH CONCENTRATIONS IN AIR SAMPLED FROM STUDY HOME I

| Compound | Concentration - ng/m$^3$ | | | |
|---|---|---|---|---|
| | Kitchen | Living Room | Bedroom | Outdoor |
| Quinoline | 1.92 | 11.67 | 7.68 | 0.50 |
| Isoquinoline | 15.50 | 6.47 | 0.43 | 0.59 |
| Phenanthrene | 88.09 | 69.05 | 42.61 | 46.45 |
| Anthracene | 72.63 | 8.19 | 2.82 | 3.57 |
| Fluoranthene | 17.32 | 16.73 | 8.87 | 12.14 |
| Pyrene | 8.11 | 8.72 | 4.37 | 7.75 |
| Cyclopenta(c,d)pyrene | 0.80 | 0.92 | 1.21 | 0.85 |
| Benz(a)anthracene | 1.16 | 0.96 | 0.76 | 2.77 |
| Chrysene | 1.49 | 1.92 | 1.08 | 4.01 |
| Benzofluoranthenes | 1.72 | 1.62 | 2.15 | 6.00 |
| Benzo(e)pyrene | 1.01 | 1.07 | 1.28 | 3.08 |
| Benzo(a)pyrene | 0.69 | 0.94 | 1.63 | 3.17 |
| Indeno(1,2,3-c,d)pyrene | 0.90 | 0.96 | 1.97 | 2.69 |
| Benzo(g,h,i)perylene | 1.79 | 2.65 | 3.20 | 4.75 |
| Coronene | 1.55 | 2.50 | 3.00 | 2.67 |

## TABLE 5.16. PAH CONCENTRATIONS IN AIR SAMPLED FROM STUDY HOME J

| Compound | Concentration - ng/m$^3$ | | | |
|---|---|---|---|---|
| | Kitchen | Living Room | Bedroom | Outdoor |
| Quinoline | 8.99 | 16.01 | 11.31 | 2.03 |
| Isoquinoline | 5.05 | 10.23 | 5.39 | 1.66 |
| Phenanthrene | 69.67 | 85.04 | 62.16 | 59.08 |
| Anthracene | 5.58 | 10.91 | 3.87 | 4.29 |
| Fluoranthene | 18.79 | 22.51 | 13.31 | 39.49 |
| Pyrene | 7.91 | 12.08 | 6.83 | 26.93 |
| Cyclopenta(c,d)pyrene | 1.70 | 2.38 | 1.45 | 2.72 |
| Benz(a)anthracene | 2.68 | 3.81 | 1.24 | 9.71 |
| Chrysene | 7.35 | 8.61 | 2.00 | 15.08 |
| Benzofluoranthenes | 5.60 | 5.87 | 4.10 | 17.74 |
| Benzo(e)pyrene | 2.06 | 2.76 | 2.10 | 9.01 |
| Benzo(a)pyrene | 3.22 | 4.13 | 2.84 | 2.02 |
| Indeno(1,2,3-c,d)pyrene | 2.37 | 2.28 | 3.53 | 8.43 |
| Benzo(g,h,i)perylene | 2.60 | 2.06 | 5.40 | 12.68 |
| Coronene | 2.10 | 1.36 | 4.75 | 7.13 |

TABLE 5.17. $NO_2$-PAH CONCENTRATIONS IN AIR SAMPLED FROM STUDY HOMES AND BACKGROUND HOMES

| Home Code | Locn Code | Concentration - $ng/m^3$ | |
|---|---|---|---|
| | | 1-Nitropyrene | 2-Nitrofluoranthene |
| A | I[a] | .069 | .032 |
| A | 0[b] | .025 | .082 |
| B | I | .026 | .030 |
| B | 0 | .038 | .086 |
| C | I | .019 | .028 |
| C | 0 | .042 | .049 |
| C2 | I | .026 | .061 |
| C2 | 0 | .019 | .185 |
| D | I | .056 | .087 |
| D | 0 | .020 | .028 |
| E | I | .052 | .143 |
| E | 0 | .013 | .120 |
| F | I | .014 | .071 |
| F | 0 | .027 | .167 |
| F2 | I | .005 | .055 |
| F2 | 0 | .017 | .161 |
| G | I | .003 | .008 |
| G | 0 | .003 | .005 |
| H | I | .004 | .067[c] |
| H | 0 | .002 | .006 |
| H | I | .010 | .013 |
| I | 0 | .038 | .052 |
| J | I | INT[c] | .134[c] |
| J | 0 | .047 | .168 |

(a) I = Indoor filter and PUF at three locations, combined samples.
(b) 0 = Outdoor filter and PUF, combined samples.
(c) INT = Interference peak coeluted with target compound.

To ensure that the measured PAH values from the combined filter and PUF extracts agreed with the sum of the values for the same filter and PUF extracts analyzed separately, selected filter and PUF extracts were analyzed separately, and those results were compared to the results from the analysis of the combined sample. The PAH data of these selected filter and PUF extracts are described in Appendix D. The summed values of PAH from the separate analyses of filter and PUF sample extracts agreed with the values from the single analysis of the combined extract. Therefore, the separate filter and PUF analyses results were summed to obtain a single concentration level for the statistical analysis.

The nitro-PAH analysis indicated that 1-nitropyrene (1-NP) and 2-nitrofluoranthene (2-NF) were in both the indoor and ambient air samples. In general, the levels of 1-nitropyrene and 2-nitrofluoranthene were at least 100 times lower than the levels of their parent compounds (pyrene and fluoranthene). The 2-nitrofluoranthene was detected at substantially higher levels than the isomeric 1-nitropyrene in all the indoor and outdoor samples except those for home A. Similar results were obtained from other studies conducted by Battelle (1,2).

## STATISTICAL ANALYSIS

The data for this pilot study were collected under a variety of experimental conditions. The relationships between the experimental factors and the observed concentration levels can be quite complex and difficult to quantify. To understand and assess these relationships and patterns more fully a statistical analysis was conducted. The analyses were based on a statistical model that provided the necessary framework to identify and quantify these relationships. The specific objectives of the analyses were:

- to identify factors that systematically and significantly contribute to the PAH levels found in the sample homes;
- to obtain range-finding estimates of the magnitudes of the effects of these factors; and

- to obtain range-finding estimates of the relative magnitudes of the different sources of variation.

To address these objectives, several types of analyses were performed. The first type involved the generation of various summary statistics concerning the observed PAH concentrations. Means, standard deviations, minimums and maximums were calculated for the different combinations of the experimental factors. Note that many of the means and standard deviations are based on only two observations, and are therefore potentially subject to large estimation errors. The second type of analysis compared indoor concentrations to outdoor concentrations. The third type involved statistical modeling to assess the relationships and relative influences of the different experimental factors on the observed concentrations.

The following sections describe the results of these statistical analyses. The results are described in detail for several of the most important compounds. The results for the remaining compounds are presented in the appendices.

## Summary Statistics

Summary statistics were generated to compare observed PAH concentrations across homes having different experimental conditions. For example, homes having woodburning fireplaces in use were compared to homes not having fireplaces in use. The summary statistics included average concentrations, standard deviations, minimums, and maximums. The comparisons across experimental conditions were done separately for the different compounds and also separately by sampling location within the home (e.g., kitchen, living room). The specific comparisons that were made are as follows:

- Homes having woodburning fireplaces in use versus those not having fireplaces in use;
- Homes having cigarette smokers present versus those not having smokers;
- Homes having gas heat and appliances versus those having electric heat and appliances; and

- Homes having different characteristics with respect to all three experimental factors (fireplace, smoking, type of heat and appliances).

The results for these comparisons are given in Tables 5.18-5.21 for benzo(a)pyrene, and in Tables 5.22-5.25 for 1-nitropyrene. Comparisons for the remaining compounds are given in Appendices E through H.

Benzo(a)pyrene. Table 5.18 indicates that typical observed BaP concentrations were in the 1-2 ng/m$^3$ range. Further, there does not appear to be a significant difference in levels due to the presence of woodburning fireplaces in use. Differences in BaP levels due to differences in location also appear to be minimal.

Table 5.19 does indicate a difference in BaP levels due to the presence of cigarette smokers in the home. The homes having smokers present had statistically significantly higher levels than those that did not. This difference was found in all the indoor sampling locations, with the differences being greatest in the living room and kitchen. As expected, there was no significant difference in outside levels between the two types of homes.

The results in Table 5.20 indicate that gas-heated homes have significantly higher BaP levels than electrically heated homes. The levels in the electrically heated homes were very low, generally around the 0.20 ng/m$^3$ level.

Table 5.21 provides a further breakdown of BaP levels by all three experimental factors simultaneously. The results confirm those of Tables 5.18-5.20. Homes having cigarette smokers present have higher BaP levels than homes having no smokers. This is shown to be uniformly true for homes having fireplaces in use, homes not having fireplaces in use, and for all locations within the home. Similarly, gas-heated homes had higher levels than electrically heated ones.

Summarizing, it appears that the type of heat source and appliances and the presence or absence of cigarette smokers have the greatest influence on BaP levels. The presence or absence of a woodburning fireplace in use does not appear to have a significant effect on the BaP levels.

TABLE 5.18. COMPARISON OF BAP LEVELS (ng/m$^3$) IN HOMES HAVING WOODBURNING FIREPLACES AND HOMES NOT HAVING WOODBURNING FIREPLACES IN USE

| | | BENZO(A)PYRENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD | N | MIN | MAX |
| LOCATION | WOOD BURNING | | | | | |
| KITCHEN | NO | 0.96 | 1.19 | 6.00 | 0.00 | 3.22 |
| | YES | 1.30 | 0.73 | 6.00 | 0.69 | 2.65 |
| LIVING ROOM | NO | 1.46 | 1.46 | 7.00 | 0.00 | 4.13 |
| | YES | 1.44 | 1.18 | 8.00 | 0.55 | 3.33 |
| BEDROOM | NO | 1.16 | 1.05 | 6.00 | 0.00 | 2.84 |
| | YES | 0.67 | 0.24 | 6.00 | 0.42 | 1.07 |
| OUTDOOR | NO | 1.64 | 1.32 | 6.00 | 0.00 | 3.17 |
| | YES | 1.24 | 0.52 | 6.00 | 0.63 | 1.94 |

TABLE 5.19. COMPARISON OF BAP LEVELS (ng/m$^3$) IN HOMES HAVING CIGARETTE SMOKERS AND HOMES NOT HAVING SMOKERS

| | | BENZO(A)PYRENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD | N | MIN | MAX |
| LOCATION | WOOD BURNING | | | | | |
| KITCHEN | NO | 0.60 | 0.43 | 7.00 | 0.00 | 0.97 |
| | YES | 1.87 | 1.03 | 5.00 | 0.93 | 3.22 |
| LIVING ROOM | NO | 0.66 | 0.36 | 9.00 | 0.00 | 1.11 |
| | YES | 2.64 | 1.20 | 6.00 | 0.90 | 4.13 |
| BEDROOM | NO | 0.59 | 0.52 | 7.00 | 0.00 | 1.63 |
| | YES | 1.37 | 0.87 | 5.00 | 0.73 | 2.84 |
| OUTDOOR | NO | 1.26 | 1.26 | 7.00 | 0.00 | 3.17 |
| | YES | 1.69 | 0.33 | 5.00 | 1.17 | 2.02 |

## TABLE 5.20. COMPARISON OF BAP LEVELS (ng/m$^3$) IN GAS-HEATED HOMES AND ELECTRICALLY HEATED HOMES

| | | BENZO(A)PYRENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD | N | MIN | MAX |
| LOCATION | HEATING SYSTEM | | | | | |
| KITCHEN | GAS | 1.36 | 0.88 | 10.00 | 0.69 | 3.22 |
| | ELECTRIC | 0.00 | 0.00 | 2.00 | 0.00 | 0.00 |
| LIVING ROOM | GAS | 1.65 | 1.24 | 13.00 | 0.55 | 4.13 |
| | ELECTRIC | 0.14 | 0.20 | 2.00 | 0.00 | 0.28 |
| BEDROOM | GAS | 1.07 | 0.74 | 10.00 | 0.42 | 2.84 |
| | ELECTRIC | 0.13 | 0.18 | 2.00 | 0.00 | 0.25 |
| OUTDOOR | GAS | 1.71 | 0.83 | 10.00 | 0.63 | 3.17 |
| | ELECTRIC | 0.10 | 0.14 | 2.00 | 0.00 | 0.24 |

## TABLE 5.21. SUMMARY OF BAP LEVELS (ng/m$^3$) FOR THE DIFFERENT COMBINATIONS OF THE EXPERIMENTAL FACTORS

HEATING SYSTEM=GAS

| | | | BENZO(A)PYRENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD | N | MIN | MAX |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 0.82 | 0.18 | 2.00 | 0.69 | 0.94 |
| | | YES | 2.07 | 1.62 | 2.00 | 0.93 | 3.22 |
| | YES | NO | 0.87 | 0.15 | 3.00 | 0.69 | 0.97 |
| | | YES | 1.73 | 0.86 | 3.00 | 0.96 | 2.65 |
| LIVING ROOM | NO | NO | 1.04 | 0.09 | 3.00 | 0.94 | 1.11 |
| | | YES | 3.42 | 1.02 | 2.00 | 2.70 | 4.13 |
| | YES | NO | 0.63 | 0.06 | 4.00 | 0.55 | 0.67 |
| | | YES | 2.25 | 1.21 | 4.00 | 0.90 | 3.33 |
| BEDROOM | NO | NO | 1.19 | 0.61 | 2.00 | 0.76 | 1.83 |
| | | YES | 2.15 | 0.97 | 2.00 | 1.46 | 2.84 |
| | YES | NO | 0.49 | 0.06 | 3.00 | 0.42 | 0.54 |
| | | YES | 0.85 | 0.19 | 3.00 | 0.73 | 1.07 |
| OUTDOOR | NO | NO | 3.01 | 0.23 | 2.00 | 0.73 | 3.17 |
| | | YES | 1.82 | 0.28 | 2.00 | 1.62 | 2.02 |
| | YES | NO | 0.87 | 0.33 | 3.00 | 0.63 | 1.24 |
| | | YES | 1.61 | 0.39 | 3.00 | 1.17 | 1.94 |

TABLE 5.21. (Continued)

HEATING SYSTEM=ELECTRIC

| | | | BENZO(A)PYRENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD | N | MIN | MAX |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 0.00 | 0.00 | 2.00 | 0.00 | 0.00 |
| LIVING ROOM | NO | NO | 0.14 | 0.20 | 2.00 | 0.00 | 0.28 |
| BEDROOM | NO | NO | 0.13 | 0.18 | 2.00 | 0.00 | 0.25 |
| OUTDOOR | NO | NO | 0.10 | 0.14 | 2.00 | 0.00 | 0.20 |

1-Nitropyrene. Due to chemical analysis costs and the small quantities expected, the samples for the different locations in each home were combined before the analyses were performed. Therefore, for 1-nitropyrene there was only one indoor sample for the entire 24-hour sampling period and one outdoor value for each home. The results of the comparisons across experimental factors are given in Tables 5.22-5.25. The results indicate the following:

- There was no significant difference between homes having wood-burning fireplaces in use and those not having fireplaces;
- There was no significant difference between homes having cigarette smokers present and those not having smokers; and
- The gas-heated homes had significantly higher levels than the electric homes.

TABLE 5.22. COMPARISON OF 1-NITROPYRENE LEVELS ($ng/m^3$) IN HOMES HAVING WOODBURNING FIREPLACES AND HOMES NOT HAVING WOODBURNING FIREPLACES IN USE

| | | 1-NITROPYRENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD | N | MIN | MAX |
| LOCATION | WOOD BURNING | | | | | |
| INDOOR, COMB | NO | 0.028 | 0.031 | 5.00 | 0.003 | 0.069 |
| | YES | 0.024 | 0.017 | 6.00 | 0.005 | 0.056 |
| OUTDOOR | NO | 0.021 | 0.019 | 6.00 | 0.002 | 0.048 |
| | YES | 0.027 | 0.010 | 6.00 | 0.017 | 0.042 |

TABLE 5.23. COMPARISON OF 1-NITROPYRENE LEVELS ($ng/m^3$) IN HOMES HAVING CIGARETTE SMOKERS AND HOMES NOT HAVING CIGARETTE SMOKERS

| | | 1-NITROPYRENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD | N | MIN | MAX |
| LOCATION | SMOKING | | | | | |
| INDOOR, COMB | NO | 0.022 | 0.023 | 7.00 | 0.003 | 0.069 |
| | YES | 0.032 | 0.026 | 4.00 | 0.005 | 0.056 |
| OUTDOOR | NO | 0.024 | 0.017 | 7.00 | 0.002 | 0.042 |
| | YES | 0.025 | 0.014 | 5.00 | 0.013 | 0.048 |

TABLE 5.24. COMPARISON OF 1-NITROPYRENE LEVELS (ng/m$^3$) IN GAS-HEATED HOMES AND ELECTRICALLY HEATED HOMES

| | | 1-NITROPYRENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD | N | MIN | MAX |
| LOCATION | HEATING SYSTEM | | | | | |
| INDOOR, COMB | GAS | 0.031 | 0.023 | 9.00 | 0.005 | 0.069 |
| | ELECTRIC | 0.003 | 0.001 | 2.00 | 0.003 | 0.004 |
| OUTDOOR | GAS | 0.029 | 0.012 | 10.00 | 0.013 | 0.048 |
| | ELECTRIC | 0.002 | 0.000 | 2.00 | 0.002 | 0.003 |

TABLE 5.25. SUMMARY OF 1-NITROPYRENE LEVELS (ng/m$^3$) FOR THE DIFFERENT COMBINATIONS OF EXPERIMENTAL PARAMETERS

HEATING SYSTEM=GAS

| | | | 1-NITROPYRENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD | N | MIN | MAX |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| INDOOR, COMB | NO | NO | 0.040 | 0.041 | 2.00 | 0.011 | 0.069 |
| | | YES | 0.053 | 0.000 | 1.00 | 0.053 | 0.053 |
| | YES | NO | 0.024 | 0.004 | 3.00 | 0.019 | 0.026 |
| | | YES | 0.025 | 0.027 | 3.00 | 0.005 | 0.056 |
| OUTDOOR | NO | NO | 0.031 | 0.009 | 2.00 | 0.025 | 0.038 |
| | | YES | 0.030 | 0.025 | 2.00 | 0.013 | 0.048 |
| | YES | NO | 0.033 | 0.012 | 3.00 | 0.019 | 0.042 |
| | | YES | 0.021 | 0.005 | 3.00 | 0.017 | 0.027 |

TABLE 5.25. (Continued)

HEATING SYSTEM=ELECTRIC

| LOCATION | WOOD BURNING | SMOKING | 1-NITROPYRENE MEAN | STD | N | MIN | MAX |
|---|---|---|---|---|---|---|---|
| INDOOR, COMB | NO | NO | 0.003 | 0.001 | 2.00 | 0.003 | 0.004 |
| OUTDOOR | NO | NO | 0.002 | 0.000 | 2.00 | 0.002 | 0.003 |

Summarizing, the type of heat source and appliances was the most important factor for 1-nitropyrene. The presence of cigarette smoking was not a significant factor for 1-nitropyrene, although it was a significant factor for most of the other compounds. The presence or absence of woodburning fireplaces in use did not appear to be significant. In fact, homes having fireplaces generally had lower observed values, though the differences were not significantly lower.

## Comparison of Indoor Levels to Outdoor Levels of the Target Compounds

The average indoor concentration of each target compound was calculated by averaging across the three sampling locations. Comparisons were made of the average PAH concentrations in indoor air and those in the outdoor air. The results of these comparisons are given in Appendix I.

Higher levels of compounds having fewer than 3 rings (e.g., quinoline) were found in the indoor air samples than in the outdoor air samples. The opposite comparative concentrations were observed for the nonvolatile compounds ($\geq$ 5 rings).

The outdoor air samples were taken over a period of 24 hours. The indoor air samples were collected over the same 24 hours, but the results reported in Appendix I are the averages of three consecutive 8-hr samples taken at three different indoor locations. The losses of volatile PAHs from the PUF cartridges may be higher in a 24-hr sampling period than in three 8-hr sampling periods. This may partially explain the lower levels of volatile PAHs found in the outdoor air samples.

Relatively lower levels of the nonvolatile PAHs, which are mainly particulate-bound, were found in the indoor samples than in the outdoor samples. This may be because some of the particulate phase PAHs from the outdoor ambient air are absorbed by building material such as filters, carpets, and walls. Therefore the effects of ambient air intrusion on the levels of the nonvolatile PAHs in indoor air may not be as important as those effects on the levels of the volatile PAHs.

Outdoor samples collected at homes G and H had relatively lower levels of all the target compounds. It was raining during sampling at these two residential sites. This meteorological effect may have contributed to the lower levels of PAHs found in the ambient air. These two homes were control homes which had all electric appliances and heating systems. No cigarette smokers were present, and there were no woodburning fireplace in use during the sampling at these homes. Therefore, the indoor PAH levels found in these two homes were the lowest of all the homes, as expected.

## Statistical Modeling

There are a number of experimental factors addressed in this study. A key objective of the study was to assess the magnitudes of the separate influences of the different factors. For example, key questions included:

- How much higher, if at all, are the PAH levels for those homes having woodburning fireplaces in use, cigarette smokers, and gas heat and appliances relative to homes not having these features?
- How much variability in PAH levels is there among different homes having identical conditions with respect to the experimental factors?
- How much do the levels vary from location to location for the same home?
- How much variability is there from day to day for the same home?

To answer these questions a statistical model was selected and fitted to the observed data. The model expressed the relationship between observed PAH levels and the experimental variables under consideration. The objectives of the modeling effort were to determine which variables have a significant influence on the concentration levels, and to quantify the magnitudes of these influences. The methodology and results of the modeling are described in the following sections. Throughout these sections, the quantitative results should be interpreted "with the small number of study homes" kept in mind. This means that the results should be considered as preliminary, range-finding estimates only, and further studies in a larger number of homes are necessary for precise quantification.

Methodology. Each compound was addressed separately in the modeling effort; however, the same model and experimental factors were used for all of them. The form of the model is given by:

$$C = \mu + SM + WB + HS + (SM*WB) + L + B_1 \cdot AER + H + D + E, \quad (1)$$

where

C is an observed concentration for the target chemical compound

μ represents the overall average concentration level taken over all the experimental conditions; the magnitudes of all deviations from the average are estimated by the remaining parameters of the model

SM represents the effect of the presence or absence of cigarette smoking in the home

WB represents the effect of the presence of a woodburning fireplace in use

HS represents the effect of the type of heat source and appliances

(SM*WB) represents the combined effect of fireplace use and smoking; that is, the combined effect of cigarette smoking and a woodburning fireplace in use may produce higher (lower) concentrations than the sum of their separate effects

L represents the effect of the specific sampling location within the home

AER represents the effect of the rate of air exchange with the outdoors on the indoor levels. Measured air exchange periods for the study homes are given in Table 5.26; $B_1$ is an unknown coefficient to be estimated from the data

H is the effect of the specific home being sampled

D is the effect of the specific sampling day (e.g., the ambient levels may affect the indoor levels) and

E represents the combined effects of all other factors not included in the model.

For each compound, the model given in Equation (1) was fitted to the observed data by using the Mixed Model Analysis of Variance program BMDP3V (10). The results of the analyses provided estimates of the contribution of each experimental factor (i.e. component of the model) to the observed concentrations.

TABLE 5.26. AIR EXCHANGE PERIODS

| Home Code | Hours per Exchange[a] |
|---|---|
| A | 2.94 |
| B | 2.86 |
| C | --[b] |
| $C_2$ | 3.45 |
| D | 4.76 |
| E | 4.76 |
| F | 1.35 |
| $F_2$ | 3.13 |
| G | 1.49 |
| H | 1.45 |
| I | 2.70 |
| J | 2.44 |

(a) The values given are the times required for the concentration of injected sulfur hexafluoride gas to decay to an undetectable level (1/e).
(b) Samples were lost during sampling.

The parameterization used to fit the model determines how the coefficient estimates are to be interpreted. In this analysis, a positive value for SM indicates that homes having cigarette smokers present have estimated concentrations above the average ($\mu$) by an amount equal to the estimated value for the parameter SM (ng/$m^3$). Similarly, homes not having smokers present would be estimated to have concentrations the same magnitude below the average. Thus, the net effect due to the presence of smoking versus non-smoking would be 2 x SM ng/$m^3$. WB and HS are interpreted similarly. A positive value for WB indicates homes having woodburning fireplaces in use have estimated concentrations above the average. A negative coefficient would indicate that homes with fireplaces in use are estimated to have lower concentration levels. A positive value for HS indicates that gas homes have higher estimated concentration levels.

The estimated value for the parameter (SM*WB) indicates the synergistic effect of the presence of both cigarette smoking and a woodburning fireplace in use. If the coefficient is positive, the net effect on concentrations of having both factors present is greater than the sum of the individual effects of SM and WB. This would imply that the effect of having the one factor present in addition to the other, results in an enhancement of the individual effects. If the coefficient is negative the synergistic effect is less than the sum of the individual ones.

The model parameter, L, indicates the effect of location within the home on the concentration. The effect is measured in terms of the deviation from average. Separate estimates are given for each of the three locations (e.g. see Table 5.27).

The model component $B_1$ is called a covariate and describes the estimated rate of change in concentration due to each additional hour required per air exchange (AER). For example, a value of $B_1 = -0.43$ for AER (see Table 5.27) indicates that the concentration level is estimated to decrease by an amount of 0.43 ng/m$^3$ for every additional hour per air exchange.

The model components H, D and E are different in nature from the other components. They are called random effects (variance components) as opposed to the others which are fixed effects. For random effects, the interest is not in the effects due to differences in specific homes or days but rather the interest is in characterizing the general variabilities among homes or days. The coefficient estimates from the analysis correspond to variance estiamtes which are estimates of the variability in concentration levels due to differences among homes or days in general.

TABLE 5.27. SUMMARY OF THE MODEL ESTIMATES FOR BENZO(A)PYRENE

| Model Component | Coefficient Estimate | Standard Error of the Estimate | t-value (Statistical Significance)[a] |
|---|---|---|---|
| HS | 0.74 | 0.27 | 2.79 (.01) |
| WB | -0.31 | 0.17 | -1.88 (.10) |
| SM | 0.73 | 0.17 | 4.31 (.01) |
| (SM*WB) | -0.21 | 0.17 | -1.24 |
| L (Kitchen) | -0.03 | 0.13 | -0.23 |
| L (Living Room) | 0.28 | 0.13 | 2.21 (.05) |
| L (Bedroom) | -0.25 | 0.13 | -1.89 (.05) |
| H[b] | 0.14 | 0.17 | -- |
| D[b] | 0.00[c] | -- | -- |
| E[b] | 0.32 | 0.09 | -- |
| AER | -0.43 | 0.15 | -2.85 (.01) |

(a) The statistical significance given in parentheses is the probability that the given coefficient (or a larger value) could have occurred by chance if the corresponding experimental factor actually had no effect on concentration level. Thus, a small significance level (e.g. less than .10) indicates the factor likely has an effect on concentration level.

(.10) indicates statistical significance at the .10 level
(.05) indicates statistical significance at the .05 level
(.01) indicates statistical significance at the .01 level
(The smaller the level the greater the statistical significance)

(b) Indicates that the corresponding coefficient represents a variance estimate rather than a systematic fixed difference in concentration levels.

(c) A value of zero for the estimated variance (coefficient estimate for a random effects factor) implies that the variability in concentration levels from day to day was negligible compared to variability due to the other factors.

The program also provides estimates for the standard errors associated with the estimates of the model effects. The standard error is related to the magnitude of the possible error associated with an estimate of the effect of a model component.

The statistical significance of an experimental factor indicates whether or not the factor has a significant influence on the home's PAH concentrations. That is, if a factor has statistical significance, the observed differences in concentrations between homes differing in that factor are not due to random chance but rather to the systematic effect of the experimental factor. The statistical significance is determined by the t-value associated with each model component.

The results of the modeling analyses are presented in the following section for the compounds benzo(a)pyrene and 1-nitropyrene. The results for the other compounds are presented in Appendix J.

Modeling Results--Benzo(a)pyrene. Table 5.27 presents a summary of the modeling results for the compound benzo(a)pyrene. The results indicate that the heat source, the presence or absence of cigarette smoking; the presence or absence of a woodburning fireplace in use; the sampling location within the home; and the rate of air exchange all had statistically significant influences on the BaP levels.

The results given in Table 5.27 can be interpreted as follows:

- Homes heated by gas had higher concentrations than did homes heated by electricity, by an estimated average of 2 x .74 = 1.48 ng/m$^3$.
- Homes in which cigarette smoking took place during sampling had higher BaP levels than those homes in which no smoking occurred. The estimated effect of smoking is to increase the BaP levels by 1.46 ng/m$^3$.
- Homes having woodburning fireplaces in use actually had lower BaP concentrations than those homes without fireplaces in use. The estimated difference was -0.62 ng/m$^3$. This effect was not as

statistically significant as those of cigarette smoking and heat source.

- The effect of the sampling location on the BaP levels differed, with the living room levels estimated to be the highest, followed by the kitchen. The living room levels are estimated to be 0.31 ng/m$^3$ (0.28-(-0.03)) higher than the kitchen levels which, in turn, are 0.22 ng/m$^3$ higher than the bedroom levels.

- Air exchange is estimated to decrease the BaP concentration by an average of 0.43 ng/m$^3$ for every increase of one hour per air exchange. That is, slower air exchange is associated with lower BaP concentrations indoors.

- The effect due to home-to-home variations is estimated to be as much as two times the standard deviation (square root of the estimated variance component given in Table 5.27) due to home-to-home variability ($\pm 2(.14)^{1/2} = 0.75$ ng/m$^3$). This indicates that homes having identical conditions with respect to the experimental factors can have BaP levels that still vary by as much as 0.75 ng/m$^3$ due to unique characteristics of the home (e.g., pilot lights, number of gas appliances).

- The variability due to all other uncontrolled factors not addressed in the model is estimated to be as much as $\pm 2(.32)^{1/2} = 1.13$ ng/m$^3$.

On a practical significance basis, cigarette smoking and the type of home heating had the greatest effects on BaP concentrations of the experimental variables. Home-to-home variability was also considerable.

Table 5.28 presents the predicted and actual mean BaP concentrations for all the different combinations of experimental factors. This table can be used to assess the combinations of conditions producing the highest and lowest BaP levels. Furthermore, comparisons of actual observed means versus those predicted by the model provide the reader with some information concerning how well the statistical model fits the observed data.

Modeling Results - 1-Nitropyrene. The compounds 1-nitropyrene and 3-nitrofluoranthene were not chemically analyzed separately by location. Rather, the samples for the kitchen, living room, and bedroom were combined for the chemical analyses so that only a single 24-hr sample was available. The statistical model for these compounds did not therefore

## TABLE 5.28. COMPARISON OF ACTUAL AND PREDICTED CONCENTRATIONS OF BENZO(A)PYRENE, in $ng/m^3$

| Gas-heated Homes | | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 0.82 | 0.95 | 2.07 | 2.83 |
| | | Living Room | 1.04 | 1.25 | 3.42 | 3.14 |
| | | Bedroom | 1.19 | 0.73 | 2.15 | 2.62 |
| | In Use | Kitchen | 0.87 | 0.74 | 1.73 | 1.78 |
| | | Living Room | 0.63 | 1.04 | 2.25 | 2.09 |
| | | Bedroom | 0.49 | 0.52 | 0.85 | 1.57 |

| Electrically Heated Homes | | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 0.00 | -0.53(a) | | |
| | | Living Room | 0.14 | -0.23 | | |
| | | Bedroom | 0.13 | -0.75 | | |

(a) The statistical estimates can be negative even though the actual levels cannot. A negative predicted value can be interpreted as being indicative of very low predicted values.

include the "location" term. Otherwise, the model was the same as that for the other compounds (see Equation 1).

The results of the modeling effort for 1-nitropyrene are given in Table 5.29. There were very few experimental observations available because samples from different locations in the home were combined. Therefore, the statistical tests given in the table are not likely to indicate a significance unless the differences due to experimental conditions were very extreme. Table 5.29 should be used primarily for its coefficient estimates. The results still, however, cannot be given too much emphasis since the number of observations was small.

The results given in Table 5.29 can be interpreted as follows:

- The type of heat source and appliances was the most important experimental factor. The presence of gas heat and appliances is estimated to increase 1-nitropyrene levels by 2 x 0.0106 ng/m$^3$ = 0.0212 ng/m$^3$ over the levels in electric homes.
- The presence or absence of cigarette smoking was estimated to have an effect that is nearly as large as that of heat source/appliances. However, the estimated effect indicates that homes having smokers have lower average 1-nitropyrene levels by an amount of 0.0194 ng/m$^3$. (When a multiplicative model (log model) was used, this effect was reversed, as discussed below.)
- The day-to-day variation in concentration of 1-nitropyrene within the same home was estimated to be an important factor relative to the other experimental factors. Day-to-day variations were estimated to be as large as $\pm$ 2 x $(0.00076)^{1/2}$ = $\pm$ 0.055 ng/m$^3$.

The effects of the presence or absence of woodburning fireplaces and home-to-home variations were all estimated to be relatively unimportant.

Table 5.30 presents the predicted and actual mean concentrations for all the different combinations of the experimental factors.

An analysis of the 1-nitropyrene data using a model that expressed the log-concentrations as an additive function of the experimental factors provided somewhat different results. The estimated effect of smoking was indicated by the log model to increase the concentration levels as one would expect. Further, home-to-home variations were found to be larger than day-to-day variations--another result similar to the results obtained for benzo(a)pyrene.

## TABLE 5.29. SUMMARY OF THE MODEL ESTIMATES FOR 1-NITROPYRENE

| Model Components | Coefficient Estimate | Standard Error of the Estimate | t-value(a) |
|---|---|---|---|
| HS | 0.0106 | 0.0184 | 0.58 |
| WB | -0.0010 | 0.0100 | -0.10 |
| SM | -0.0097 | 0.0106 | -0.92 |
| (WB*SM) | 0.0009 | 0.0121 | 0.07 |
| H(b) | 0.0000006(b) | 0.000000 | |
| D(b) | 0.00076(b) | 0.00062 | |
| E(b) | 0.0000010(b) | 0.000000 | |
| AER | 0.0113 | 0.0109 | 1.04 |

(a) None of these effects was statistically significant at the 0.10 level.

(b) The corresponding coefficient represents a variance estimate rather than a systematic fixed difference in concentrations.

## TABLE 5.30. COMPARISON OF ACTUAL AND PREDICTED CONCENTRATIONS OF 1-NITROPYRENE, in $ng/m^3$

| | | Smoking | | | |
|---|---|---|---|---|---|
| | | Absent | | Present | |
| | Woodburning Fireplace | Actual | Predicted | Actual | Predicted |
| Gas-heated Homes | Absent | 0.0397 | 0.0404 | 0.0525 | 0.0192 |
| | Present | 0.0260 | 0.0367 | 0.0246 | 0.0190 |
| Electrically Heated Homes | Absent | 0.0032 | 0.0192 | | |
| | Present | | | | |

## 5.5 SUMMARY OF RESULTS FOR THE REMAINING POLLUTANTS

The same modeling techniques were applied to all the other compounds in addition to BaP and 1-nitropyrene. The results are summarized in Appendix J, where tables are presented individually for each compound. The tables are analogous to Tables 5.27 and 5.28, which present estimates for the coefficients of the fitted model, and comparisons of predicted values and actual values.

The results for the remaining compounds are similar to those for BaP. The general findings are as follows:

- Homes having gas heat and appliances generally had higher levels than homes with electric heat and appliances.
- Homes having cigarette smokers present generally had higher levels than those that did not.
- The relationship between pollutant levels and the use of a woodburning fireplace was not clear. Homes not having woodburning fireplaces were actually estimated to have higher levels for many of the compounds. Examination of the levels for the different homes indicates that this was not due to a single extreme value.
- The living room levels tended to be higher than the kitchen levels, which in turn were higher than the bedroom levels.
- The effect of interaction between fireplace use and cigarette smoking was generally not statistically significant.
- The effect of air exchange was statistically significant for only a few compounds.
- Uncontrolled variation not considered by the model (random error) was the largest single source of variation. Home-to-home variation was generally second largest, while day-to-day variation was the smallest.

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# APPENDIX A

# ACTIVITY LOGS FOR THE STUDY AND BACKGROUND HOMES

## ACTIVITY REPORT

HOME A SAMPLING START TIME 0700

SAMPLING DATE 3/12/84 to 3/13/84

Cooking times (Begin-End):

7:00 AM/7:30 PM - fry pan used to scramble eggs
7:00 PM/8:00 PM - boiled noodles
7:30 AM/8:00 SM - fry pan used to scramble eggs

Cooking type (broiled, fried, baked):

frying, boiling - range has 3 pilot lights

Time wood burning fireplace in use (begin-end):

Not use

No. of door openings each sampling period:

12 door openings + ~20 openings for sampling personnel

No. of cigarettes smoked:

None in sampling house but 2 candles burned for 2 hours during dinner. (4 cigarettes next door ~24 hour period)

Attached garage (Y/N):

No

Time automobile motor running in attached garage:

Started diesel car twice parked outside about 6 feet from sample home

No. of stories of home:

3 including basement

Age of home:

~35 years

Size of home (ft$^2$):

1600 ft$^2$

Comments: Temperature 7:00 AM 3/12/84 - bedroom 70°F - outside 15°F

# Questionnaire for Volunteer Homes[a]

Home: _A_______________________

(1) Type of heating? _____electric __X__gas

(2) Type of cooking? _____electric __X__gas

If gas, with pilot light? __X__yes _____no

(3) Do residents smoke? _____yes __X__no

If yes, approx. how many cigarettes/day smoked in home __0__

(4) Wood burning fireplace: _____yes __X__no

(5) Style of home: __X__2-story _____ranch _____split _____(other)

(6) Age of home: _____0-5 yrs _____5-10 yrs __X__>10 yrs

(7) Size of home: __2440__ sq. ft (approx.)

(8) Will home be occupied during sampling? __X__yes _____no

(9) Two power circuits are required (110v/20A) during sampling. Are these available? __X__yes _____no

(10) Two windows are needed for the entry of the sampling line

Kitchen or first floor window __X__yes _____no

Bedroom window __X__yes _____no

[a] The questionnaire was preliminary, used to select homes for study

# ACTIVITY REPORT

HOME B SAMPLING START TIME 0700

SAMPLING DATE 3/13/84

Cooking times (Begin-End):

5:30 PM/6:30 PM

Cooking type (broiled, fried, baked):

fried

Time wood burning fireplace in use (begin-end):

7:15 PM/10:15 PM

No. of door openings each sampling period:

No. of cigarettes smoked:

None

Attached garage (Y/N):

Yes

Time automobile motor running in attached garage:

1-2 minutes

No. of stories of home:

2

Age of home:

11 1/2 years

Size of home ($ft^2$):

1800 $ft^2$

Comments:

## Questionnaire for Volunteer Homes(a)

Home: __B__________________

(1) Type of heating? _____electric __X__gas

(2) Type of cooking? _____electric __X__gas

If gas, with pilot light? __X__yes _____no

(3) Do residents smoke? _____yes __X__no

If yes, approx. how many cigarettes/day smoked in home __0__

(4) Wood burning fireplace: __X__yes _____no

(5) Style of home: __X__2-story _____ranch _____split _____(other)

(6) Age of home: _____0-5 yrs _____5-10 yrs __X__>10 yrs

(7) Size of home: __2000__ sq. ft (approx.)

(8) Will home be occupied during sampling? __X__yes _____no

(9) Two power circuits are required (110v/20A) during sampling. Are these available? __X__yes _____no

(10) Two windows are needed for the entry of the sampling line

Kitchen or first floor window __X__yes _____no

Bedroom window __X__yes _____no

(a) The questionnaire was preliminary, used to select homes for study

## ACTIVITY REPORT

HOME C SAMPLING START TIME ________

SAMPLING DATE 3/13/84 to 3/14/84

Cooking times (Begin-End):

5:30 PM/6:30 PM
7:30 AM/7:40 AM

Cooking type (broiled, fried, baked):

boil and fry

Time wood burning fireplace in use (begin-end):

7:30 PM/11:45 PM

No. of door openings each sampling period:

19

No. of cigarettes smoked:

None

Attached garage (Y/N):

Carport

Time automobile motor running in attached garage:

No. of stories of home:

3

Age of home:

27 years

Size of home ($ft^2$):

1800 $ft^2$

Comments:

# ACTIVITY REPORT

HOME C2 SAMPLING START TIME ________

SAMPLING DATE 3/13/84 to 3/14/84

Cooking times (Begin-End):

4:45 PM/4:50 PM
5:45 PM/5:50 PM
7:15 AM/7:20 AM

Cooking type (broiled, fried, baked):

boil

Time wood burning fireplace in use (begin-end):

7:45 PM/10:30 PM

No. of door openings each sampling period:

12

No. of cigarettes smoked:

None

Attached garage (Y/N):

Carport

Time automobile motor running in attached garage:

No. of stories of home:

3

Age of home:

27 years

Size of home ($ft^2$):

1700 $ft^2$

Comments:

## Questionnaire for Volunteer Homes[a]

Home: C (C2)

(1) Type of heating? _____ electric __X__ gas

(2) Type of cooking? _____ electric __X__ gas

If gas, with pilot light? _____ yes __X__ no

(3) Do residents smoke? _____ yes __X__ no

If yes, approx. how many cigarettes/day smoked in home __0__

(4) Wood burning fireplace: __X__ yes _____ no

(5) Style of home: _____ 2-story _____ ranch __X__ split _____ (other)

(6) Age of home: _____ 0-5 yrs _____ 5-10 yrs __X__ >10 yrs

(7) Size of home: __2200__ sq. ft (approx.)

(8) Will home be occupied during sampling? __X__ yes _____ no

(9) Two power circuits are required (110v/20A) during sampling. Are these available? __X__ yes _____ no

(10) Two windows are needed for the entry of the sampling line

Kitchen or first floor window __X__ yes _____ no

Bedroom window __X__ yes _____ no

---

(a) The questionnaire was prelminary, used to select homes for study

# ACTIVITY REPORT

HOME D SAMPLING START TIME 1300

SAMPLING DATE 3/14/84

Cooking times (Begin-End):

7:00 PM/8:35 PM
7:50 PM/8:35 PM
7:00 AM/7:10 AM

Cooking type (broiled, fried, baked):

boil, fry and baking

Time wood burning fireplace in use (begin-end):

6:30 PM/10:00 PM during LR sampling - Last log went on at 9:00 PM;
last "poked-up" at 10:00 PM - damper closed at 2:05 AM

No. of door openings each sampling period:

25

No. of cigarettes smoked:

Housekeeper here 7:00 AM/12:30 PM, adding to the number of cigarettes smoked. A total of 36 cigarettes smoked.

Attached garage (Y/N):

No

Time automobile motor running in attached garage:

No. of stories of home:

2

Age of home:

6 1/2 years

Size of home ($ft^2$):

1800 $ft^2$ including basement, because door is always open.

Comments:

## Questionnaire for Volunteer Homes[a]

Home: D

(1) Type of heating? _____ electric X gas

(2) Type of cooking? _____ electric X gas

If gas, with pilot light? X yes _____ no

(3) Do residents smoke? X yes _____ no

If yes, approx. how many cigarettes/day smoked in home 30-40

(4) Wood burning fireplace: X yes _____ no

(5) Style of home: X 2-story _____ ranch _____ split _____ (other)

(6) Age of home: _____ 0-5 yrs X 5-10 yrs _____ >10 yrs

(7) Size of home: 1500 sq. ft (approx.)

(8) Will home be occupied during sampling? X yes _____ no

(9) Two power circuits are required (110v/20A) during sampling. Are these available? X yes _____ no

(10) Two windows are needed for the entry of the sampling line

Kitchen or first floor window X yes _____ no

Bedroom window X yes _____ no

[a] The questionnaire was preliminary, used to select homes for study

## ACTIVITY REPORT

HOME E    SAMPLING START TIME 1530

SAMPLING DATE 3/19/84 to 3/20/85

Cooking times (Begin-End):

Cooking type (broiled, fried, baked):

Time wood burning fireplace in use (begin-end):

No. of door openings each sampling period:

7

No. of cigarettes smoked:

36

Attached garage (Y/N):

No

Time automobile motor running in attached garage:

No. of stories of home:

1 1/2

Age of home:

~60 years

Size of home ($ft^2$):

800 $ft^2$

Comments:

## Questionnaire for Volunteer Homes(a)

Home: E

(1) Type of heating? ____ electric X gas

(2) Type of cooking? X electric ____ gas

If gas, with pilot light? ____ yes ____ no

(3) Do residents smoke? X yes ____ no

If yes, approx. how many cigarettes/day smoked in home 60

(4) Wood burning fireplace: ____ yes X no

(5) Style of home: ____ 2-story ____ ranch ____ split X (other)

(6) Age of home: ____ 0-5 yrs ____ 5-10 yrs X >10 yrs

(7) Size of home: 720 sq. ft (approx.)

(8) Will home be occupied during sampling? X yes ____ no

(9) Two power circuits are required (110v/20A) during sampling. Are these available? X yes ____ no

(10) Two windows are needed for the entry of the sampling line

Kitchen or first floor window X yes ____ no

Bedroom window X yes ____ no

(a) The questionnaire was preliminary, used to select homes for study

## ACTIVITY REPORT

HOME F

SAMPLING START TIME 1500

SAMPLING DATE 3/19/84

Cooking times (Begin-End):

1815/1830

Cooking type (broiled, fried, baked):

boiling and microwave

Time wood burning fireplace in use (begin-end):

3 hours

No. of door openings each sampling period:

14

No. of cigarettes smoked:

13

Attached garage (Y/N):

Yes

Time automobile motor running in attached garage:

No. of stories of home:

2 1/2

Age of home:

20 years

Size of home ($ft^2$):

1600 $ft^2$

Comments: Sprayed for ants on 3/18/84

# ACTIVITY REPORT

HOME F2 SAMPLING START TIME 1500

SAMPLING DATE 3/27/84 to 3/28/84

Cooking times (Begin-End):

5:00 PM/5:30 PM

Cooking type (broiled, fried, baked):

fried

Time wood burning fireplace in use (begin-end):

3 hours

No. of door openings each sampling period:

15

No. of cigarettes smoked:

16

Attached garage (Y/N):

Yes

Time automobile motor running in attached garage:

seconds

No. of stories of home:

2

Age of home:

20 years

Size of home ($ft^2$):

1600 $ft^2$

Comments:

## Questionnaire for Volunteer Homes(a)

Home: F (F2)

(1) Type of heating? _____electric __X__gas

(2) Type of cooking? __X__electric _____gas

If gas, with pilot light? _____yes _____no

(3) Do residents smoke? __X__yes _____no

If yes, approx. how many cigarettes/day smoked in home __20__

(4) Wood burning fireplace: __X__yes _____no

(5) Style of home: _____2-story _____ranch __X__split _____(other)

(6) Age of home: _____0-5 yrs _____5-10 yrs __X__>10 yrs

(7) Size of home: __2000__ sq. ft (approx.)

(8) Will home be occupied during sampling? __X__yes _____no

(9) Two power circuits are required (110v/20A) during sampling. Are these available? _____yes _____no

(10) Two windows are needed for the entry of the sampling line

Kitchen or first floor window __X__yes _____no

Bedroom window __X__yes _____no

---

(a) The questionnaire was preliminary, used to select homes for study

## Questionnaire for Volunteer Homes[a]

Home: G

(1) Type of heating? X electric ____ gas

(2) Type of cooking? X electric ____ gas

If gas, with pilot light? ____ yes ____ no

(3) Do residents smoke? ____ yes X no

If yes, approx. how many cigarettes/day smoked in home 0

(4) Wood burning fireplace: X yes ____ no
Wood burning fireplace never used since moved in and wood burning fireplace was not in use during sampling.

(5) Style of home: ____ 2-story ____ ranch X split ____ (other)

(6) Age of home: X 0-5 yrs ____ 5-10 yrs ____ >10 yrs

(7) Size of home: 1800 sq. ft (approx.)

(8) Will home be occupied during sampling? X yes ____ no

(9) Two power circuits are required (110v/20A) during sampling. Are these available? X yes ____ no

(10) Two windows are needed for the entry of the sampling line

Kitchen or first floor window X yes ____ no

Bedroom window X yes ____ no

[a] The questionnaire was preliminary, used to select homes for study and the activity record was not reported by home G residents.

## ACTIVITY REPORT

HOME H SAMPLING START TIME 1500

SAMPLING DATE 3/21/84

Cooking times (Begin-End):

1900/1930

Cooking type (broiled, fried, baked):

baked

Time wood burning fireplace in use (begin-end):

None

No. of door openings each sampling period:

1

No. of cigarettes smoked:

None

Attached garage (Y/N):

Yes

Time automobile motor running in attached garage:

1 minute 3/21/84
1 minute 3/22/84

No. of stories of home:

2

Age of home:

1 month

Size of home ($ft^2$):

1900 $ft^2$

Comments:

# Questionnaire for Volunteer Homes[a]

Home: H

(1) Type of heating? X electric ____ gas

(2) Type of cooking? X electric ____ gas

If gas, with pilot light? ____ yes ____ no

(3) Do residents smoke? ____ yes X no

If yes, approx. how many cigarettes/day smoked in home 0

(4) Wood burning fireplace: X yes ____ no
Wood burning fireplace was not in use during sampling.

(5) Style of home: X 2-story ____ ranch ____ split ____ (other)

(6) Age of home: X 0-5 yrs ____ 5-10 yrs ____ >10 yrs

(7) Size of home: 1850 sq. ft (approx.)

(8) Will home be occupied during sampling? X yes ____ no

(9) Two power circuits are required (110v/20A) during sampling. Are these available? X yes ____ no

(10) Two windows are needed for the entry of the sampling line

Kitchen or first floor window X yes ____ no

Bedroom window X yes ____ no

(a) The questionnaire was preliminary, used to select homes for study.

## Questionnaire for Volunteer Homes[a]

Home: I

(1) Type of heating? _____electric __X__gas

(2) Type of cooking? _____electric __X__gas

If gas, with pilot light? __X__yes _____no

(3) Do residents smoke? _____yes __X__no

If yes, approx. how many cigarettes/day smoked in home __0__

(4) Wood burning fireplace: __X__yes _____no
Wood burning fireplace was not in use during sampling.

(5) Style of home: _____2-story _____ranch __X__split _____(other)

(6) Age of home: _____0-5 yrs _____5-10 yrs __X__>10 yrs

(7) Size of home: ________ sq. ft (approx.)

(8) Will home be occupied during sampling? __X__yes _____no

(9) Two power circuits are required (110v/20A) during sampling. Are these available? __X__yes _____no

(10) Two windows are needed for the entry of the sampling line

Kitchen or first floor window __X__yes _____no

Bedroom window __X__yes _____no

[a] The questionnaire was preliminary, used to select homes for study and the activity record was not reported by home I residents.

# ACTIVITY REPORT

HOME J SAMPLING START TIME 1600

SAMPLING DATE 3/23/84

Cooking times (Begin-End):

(1) 5:45 PM/6:05 PM (2) 9:30 AM/9:25 AM (3) 8:00 AM/10:30 AM
(4) 10:30 AM/2:20 PM (5) 2:30 PM/3:05 PM

Cooking type (broiled, fried, baked):

(1) fried fish (2) fried (3) Periodic boiling of water
(4) boil (stewing) (5) baked

Time wood burning fireplace in use (begin-end):

N/A

No. of door openings each sampling period:

(1) 12 (2) 1 (3) 17

No. of cigarettes smoked:

58

Attached garage (Y/N):

Yes

Time automobile motor running in attached garage:

None

No. of stories of home:

4 - level split

Age of home:

14 years

Size of home ($ft^2$):

1860 $ft^2$ (excluding basement)

Comments:

## Questionnaire for Volunteer Homes(a)

Home: J

(1) Type of heating? ____ electric _X_ gas

(2) Type of cooking? ____ electric _X_ gas

If gas, with pilot light? _X_ yes ____ no

(3) Do residents smoke? ____ yes _X_ no

If yes, approx. how many cigarettes/day smoked in home ____

(4) Wood burning fireplace: ____ yes _X_ no

(5) Style of home: ____ 2-story ____ ranch _X_ split ____ (other)

(6) Age of home: _X_ 0-5 yrs ____ 5-10 yrs ____ > 10 yrs

(7) Size of home: 1900 sq. ft (approx.)

(8) Will home be occupied during sampling? _X_ yes ____ no

(9) Two power circuits are required (110v/20A) during sampling. Are these available? _X_ yes ____ no

(10) Two windows are needed for the entry of the sampling line

Kitchen or first floor window _X_ yes ____ no

Bedroom window _X_ yes ____ no

# APPENDIX B

# SAMPLING VOLUMES

TABLE B-1. SAMPLING VOLUMES FOR THE STUDY HOMES AND BACKGROUND HOMES

| Home Code | Total Volume Sampled, $m^3$ | | | |
|---|---|---|---|---|
| | Kitchen | Living Room | Bedroom | Outdoor |
| A | 112.28 | 104.19 | 126.53 | 335.08 |
| B | 111.46 | 66.11 | 99.84 | 343.99 |
| C | 113.31 | 98.93 | 100.89 | 338.58 |
| $C_2$(K) | 95.51 | 95.09 | 102.26 | 313.79 |
| D | 100.95 | 102.26 | 107.90 | 313.79 |
| E | 105.93 | 105.28 | 105.28 | 309.72 |
| F | 107.07 | 96.82 | 111.63 | 308.32 |
| $F_2$(L) | 100.46 | 102.42 | 104.60 | 331.11 |
| G | 109.55 | 101.72 | 102.19 | 307.93 |
| H | 101.38 | 108.43 | 103.29 | 315.97 |
| I | 107.07 | 106.41 | 110.72 | 355.53 |
| J | 103.66 | 105.93 | 116.19 | 313.79 |

# APPENDIX C

## SAMPLE AND LABORATORY BLANK RESULTS

## TABLE C-1. PAH AND NO$_2$-PAH FOUND IN THE PUF AND FILTER BLANK SAMPLES

| Compound | Total Amount Found in One Filter or PUF, µg | | |
|---|---|---|---|
| | PUF Blank 1 | PUF Blank 2 | Filter Blank |
| Quinoline | ND | <0.01 | 0.02 |
| Isoquinoline | <0.01 | <0.01 | <0.01 |
| Phenanthrene | 0.27 | 0.34 | 0.13 |
| Anthracene | 0.02 | 0.03 | 0.02 |
| Fluoranthene | 0.16 | 0.26 | 0.06 |
| Pyrene | 0.08 | 0.13 | 0.05 |
| Cyclopenta(c,d)pyrene | ND(c) | ND | ND |
| Benz(a)anthracene | ND | <0.01 | ND |
| Chrysene | ND | <0.01 | ND |
| Benzofluoranthene | ND | ND | ND |
| Benzo(e)pyrene | ND | ND | ND |
| Benzo(a)pyrene | ND | ND | ND |
| Indeno(1,2,3-c,d)pyrene | ND | ND | ND |
| Benzo(g,h,i)perylene | ND | ND | ND |
| Coronene | ND | ND | ND |
| 1-Nitropyrene | ND | ND | ND |
| 2-Nitrofluoranthene | ND | ND | ND |

(a) PUF blank 1 was stored for one week between cleaning and extraction.

(b) PUF blank 2 was stored for two weeks between cleaning and extraction.

(c) ND = not detected.

# APPENDIX D

## PAH DATA FOR SELECTED FILTER AND PUF SAMPLES ANALYZED SEPARATELY AND THE SAME FILTER AND PUF ANALYZED AS COMBINED SAMPLES

## TABLE D-1. COMPARISON OF THE PAH DATA FOR SELECTED FILTER AND PUF SAMPLES ANALYZED SEPARATELY AND THE SAME FILTER AND PUF COMBINED SAMPLES

| | Concentration, ng/m$^3$ | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Home A, Living Room | | | | Home B, Living Room | | | | Home F | | | |
| Compound | Filter | PUF | Sum of Filter & PUF | Filter & PUF Combined Sample | Filter | PUF | Sum of Filter & PUF | Filter & PUF Combined Sample | Filter | PUF | Sum of Filter & PUF | Filter & PUF Combined Sample |
| Quinoline | 0.31 | 1.34 | 1.65 | 1.34 | 0.24 | 1.21 | 1.45 | 1.63 | 0.39 | 25.06 | 25.45 | 31.23 |
| Isoquinoline | 0.17 | 0.71 | 0.88 | 1.02 | 0.15 | 0.82 | 0.97 | 1.27 | 0.29 | 10.60 | 10.89 | 13.63 |
| Phenanthrene | 3.80 | 56.57 | 60.37 | 72.02 | 2.78 | 83.53 | 86.31 | 88.52 | 7.75 | 105.78 | 113.53 | 132.33 |
| Anthracene | 0.42 | 2.40 | 2.82 | 3.67 | 0.49 | 6.60 | 7.09 | 5.81 | 0.70 | 6.14 | 6.84 | 8.12 |
| Fluoranthene | 6.28 | 15.68 | 21.96 | 22.54 | 3.42 | 19.51 | 22.93 | 25.17 | 12.56 | 24.23 | 36.79 | 37.37 |
| Pyrene | 2.32 | 8.50 | 10.82 | 11.17 | 1.82 | 8.83 | 10.65 | 10.38 | 3.74 | 12.29 | 16.03 | 18.10 |
| Cyclopenta[c,d]pyrene | 0.42 | 0.25 | 0.67 | 0.52 | 0.09 | 0.06 | 0.15 | 0.18 | 0.29 | 0.12 | 0.41 | 0.35 |
| Benz[a]anthracene | 0.46 | 0.31 | 0.77 | 0.67 | 0.30 | 0.21 | 0.51 | 0.64 | 1.41 | 0.95 | 2.36 | 2.25 |
| Chrysene | 0.96 | 0.52 | 1.48 | 1.42 | 0.67 | 0.24 | 0.91 | 1.21 | 3.04 | 1.86 | 4.90 | 5.25 |
| Benzofluorenthenes | 2.13 | ND | 2.13 | 1.82 | 1.15 | ND | 1.15 | 1.21 | 6.57 | ND | 6.57 | 5.83 |
| Benzo[e]pyrene | 1.00 | ND | 1.00 | 0.98 | 0.88 | ND | 0.88 | 1.03 | 3.57 | ND | 3.57 | 3.12 |
| Benzo[a]pyrene | 1.11 | ND | 1.11 | 1.07 | 0.64 | ND | 0.64 | 0.67 | 3.22 | ND | 3.22 | 3.33 |
| Indeno[1,2,3-c,d]pyrene | 1.04 | ND | 1.04 | 0.83 | 0.51 | ND | 0.51 | 0.48 | 2.75 | ND | 2.75 | 2.58 |
| Benzo[g,h,i]perylene | 1.65 | ND | 1.65 | 1.40 | 0.70 | ND | 0.70 | 0.82 | 2.83 | ND | 2.83 | 2.77 |
| Coronene | 1.17 | ND | 1.17 | 1.00 | 0.39 | ND | 0.39 | 0.30 | 1.14 | ND | 1.14 | 0.91 |

# APPENDIX E

# COMPARISON OF PAH CONCENTRATIONS ($ng/m^3$) FOR HOMES HAVING WOODBURNING FIREPLACES IN USE AND HOMES NOT HAVING FIREPLACES: ALL OTHER TARGET COMPOUNDS

TABLE E-1. COMPARISON OF QUINOLINE LEVELS (ng/m$^3$) FOR HOMES HAVING WOODBURNING FIREPLACES IN USE AND HOMES NOT HAVING WOODBURNING FIREPLACES IN USE.

| | | QUINOLINE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | | | | | |
| KITCHEN | NO | 4.68 | 4.11 | 8.00 | 1.02 | 10.40 |
| | YES | 6.02 | 5.75 | 6.00 | 0.29 | 13.78 |
| LIVING ROOM | NO | 10.19 | 13.25 | 7.00 | 0.51 | 37.04 |
| | YES | 8.74 | 10.69 | 8.00 | 1.45 | 31.23 |
| BEDROOM | NO | 5.44 | 5.32 | 6.00 | 0.33 | 11.40 |
| | YES | 4.02 | 2.70 | 6.00 | 1.37 | 7.72 |
| OUTDOOR | NO | 0.95 | 0.72 | 6.00 | 0.21 | 2.03 |
| | YES | 0.36 | 0.28 | 6.00 | 0.11 | 0.88 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE E-2. COMPARISON OF ISOQUINOLINE LEVELS ($ng/m^3$) FOR HOMES HAVING WOODBURNING FIREPLACES IN USE AND HOMES NOT HAVING WOODBURNING FIREPLACES IN USE.

| | | ISOQUINOLINE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD[a] | N[a] | MIN[a] | MAX[a] |
| LOCATION | WOOD BURNING | | | | | |
| KITCHEN | NO | 10.56 | 15.84 | 6.00 | 0.57 | 40.71 |
| | YES | 2.72 | 2.01 | 6.00 | 0.69 | 4.77 |
| LIVING ROOM | NO | 6.22 | 8.47 | 7.00 | 0.52 | 23.50 |
| | YES | 4.37 | 4.77 | 8.00 | 0.95 | 13.63 |
| BEDROOM | NO | 12.16 | 25.06 | 6.00 | 0.43 | 63.18 |
| | YES | 4.25 | 4.64 | 6.00 | 0.91 | 13.17 |
| OUTDOOR | NO | 0.78 | 0.54 | 6.00 | 0.18 | 1.66 |
| | YES | 0.82 | 0.74 | 6.00 | 0.15 | 1.75 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE E-3. COMPARISON OF PHENANTHRENE LEVELS (ng/m$^3$) FOR HOMES HAVING WOODBURNING FIREPLACES IN USE AND HOMES NOT HAVING WOODBURNING FIREPLACES IN USE.

| | | PHENANTHRENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | | | | | |
| KITCHEN | NO | 57.30 | 19.70 | 6.00 | 34.54 | 88.09 |
| | YES | 92.46 | 34.74 | 6.00 | 55.16 | 143.58 |
| LIVING ROOM | NO | 63.17 | 16.70 | 7.00 | 33.77 | 85.04 |
| | YES | 99.08 | 28.31 | 8.00 | 62.49 | 132.33 |
| BEDROOM | NO | 52.30 | 17.76 | 6.00 | 24.13 | 75.61 |
| | YES | 64.81 | 27.69 | 6.00 | 54.61 | 116.81 |
| OUTDOOR | NO | 36.01 | 16.38 | 6.00 | 10.10 | 59.08 |
| | YES | 42.34 | 17.30 | 6.00 | 26.57 | 75.13 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE E-4. COMPARISON OF ANTHRACENE LEVELS ($ng/m^3$) FOR HOMES HAVING WOODBURNING FIREPLACES IN USE AND HOMES NOT HAVING WOODBURNING FIREPLACES IN USE.

| | | ANTHRACENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD[a] | N[a] | MIN[a] | MAX[a] |
| LOCATION | WOOD BURNING | | | | | |
| KITCHEN | NO | 14.63 | 28.34 | 6.00 | 1.48 | 72.63 |
| | YES | 5.63 | 4.00 | 6.00 | 2.14 | 13.25 |
| LIVING ROOM | NO | 5.42 | 3.60 | 7.00 | 1.48 | 10.91 |
| | YES | 6.12 | 2.69 | 8.00 | 2.50 | 10.52 |
| BEDROOM | NO | 3.53 | 2.14 | 6.00 | 1.32 | 7.50 |
| | YES | 4.40 | 2.19 | 6.00 | 2.27 | 7.77 |
| OUTDOOR | NO | 2.70 | 1.55 | 6.00 | 0.58 | 4.29 |
| | YES | 3.01 | 1.93 | 6.00 | 1.20 | 6.41 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE E-5. COMPARISON OF FLUORANTHENE LEVELS (ng/m$^3$) FOR HOMES HAVING WOODBURNING FIREPLACES IN USE AND HOMES NOT HAVING WOODBURNING FIREPLACES IN USE.

| | | FLUORANTHENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N[a] | MIN[a] | MAX [a] |
| LOCATION | WOOD BURNING | | | | | |
| KITCHEN | NO | 13.74 | 3.88 | 6.00 | 9.23 | 18.79 |
| | YES | 20.93 | 5.17 | 6.00 | 12.98 | 26.37 |
| LIVING ROOM | NO | 18.15 | 4.72 | 7.00 | 9.94 | 22.54 |
| | YES | 26.75 | 7.09 | 8.00 | 18.36 | 37.37 |
| BEDROOM | NO | 11.79 | 4.39 | 6.00 | 5.11 | 17.99 |
| | YES | 19.39 | 3.40 | 6.00 | 13.65 | 22.66 |
| OUTDOOR | NO | 16.61 | 12.07 | 6.00 | 4.75 | 39.49 |
| | YES | 14.62 | 3.52 | 6.00 | 11.95 | 20.71 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE E-6. COMPARISON OF PYRENE LEVELS (ng/m$^3$) FOR HOMES HAVING WOODBURNING FIREPLACES IN USE AND HOMES NOT HAVING WOODBURNING FIREPLACES IN USE.

| | | PYRENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | | | | | |
| KITCHEN | NO | 6.27 | 1.43 | 6.00 | 4.79 | 8.11 |
| | YES | 9.75 | 2.62 | 6.00 | 5.67 | 13.25 |
| LIVING ROOM | NO | 8.71 | 2.88 | 7.00 | 4.30 | 12.08 |
| | YES | 11.86 | 3.72 | 8.00 | 7.28 | 18.10 |
| BEDROOM | NO | 5.28 | 1.62 | 6.00 | 2.67 | 7.01 |
| | YES | 8.67 | 1.92 | 6.00 | 5.81 | 10.86 |
| OUTDOOR | NO | 10.52 | 8.79 | 6.00 | 2.54 | 26.93 |
| | YES | 8.04 | 2.68 | 6.00 | 5.84 | 13.00 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE E-7. COMPARISON OF CYCLOPENTA(c,d)PYRENE LEVELS (ng/m$^3$) FOR HOMES HAVING WOODBURNING FIREPLACES IN USE AND HOMES NOT HAVING WOODBURNING FIREPLACES IN USE.

| | | CYCLOPENTA(C,D)PYRENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N[a] | MIN[a] | MAX [a] |
| LOCATION | WOOD BURNING | | | | | |
| KITCHEN | NO | 0.64 | 0.59 | 6.00 | 0.00 | 1.70 |
| | YES | 0.59 | 0.59 | 6.00 | 0.00 | 1.72 |
| LIVING ROOM | NO | 0.89 | 0.82 | 7.00 | 0.00 | 2.38 |
| | YES | 0.40 | 0.31 | 8.00 | 0.15 | 1.11 |
| BEDROOM | NO | 0.63 | 0.60 | 8.00 | 0.00 | 1.45 |
| | YES | 0.19 | 0.12 | 8.00 | 0.00 | 0.30 |
| OUTDOOR | NO | 1.32 | 1.54 | 8.00 | 0.07 | 3.74 |
| | YES | 0.38 | 0.24 | 8.00 | 0.10 | 0.64 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE E-8. COMPARISON OF BENZ(a)ANTHRACENE LEVELS (ng/m$^3$) FOR HOMES HAVING WOODBURNING FIREPLACES IN USE AND HOMES NOT HAVING WOODBURNING FIREPLACES IN USE.

| | | BENZ(a)ANTHRACENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N[a] | MIN[a] | MAX [a] |
| LOCATION | WOOD BURNING | | | | | |
| KITCHEN | NO | 0.97 | 0.90 | 8.00 | 0.26 | 2.68 |
| | YES | 1.21 | 0.81 | 8.00 | 0.44 | 2.77 |
| LIVING ROOM | NO | 1.36 | 1.23 | 7.00 | 0.31 | 3.81 |
| | YES | 1.18 | 0.80 | 8.00 | 0.30 | 2.35 |
| BEDROOM | NO | 0.63 | 0.47 | 6.00 | 0.00 | 1.24 |
| | YES | 0.63 | 0.24 | 6.00 | 0.38 | 0.98 |
| OUTDOOR | NO | 2.84 | 3.54 | 6.00 | 0.23 | 9.71 |
| | YES | 1.11 | 0.38 | 6.00 | 0.67 | 1.82 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE E-9. COMPARISON OF CHRYSENE LEVELS ($ng/m^3$) FOR HOMES HAVING WOODBURNING FIREPLACES IN USE AND HOMES NOT HAVING WOODBURNING FIREPLACES IN USE.

| | | CHRYSENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | | | | | |
| KITCHEN | NO | 2.14 | 2.59 | 6.00 | 0.57 | 7.35 |
| | YES | 2.11 | 1.30 | 6.00 | 1.09 | 4.58 |
| LIVING ROOM | NO | 2.82 | 2.87 | 7.00 | 0.68 | 8.61 |
| | YES | 2.56 | 1.74 | 8.00 | 0.87 | 5.25 |
| BEDROOM | NO | 1.17 | 0.70 | 6.00 | 0.41 | 2.03 |
| | YES | 1.36 | 0.43 | 6.00 | 0.92 | 1.77 |
| OUTDOOR | NO | 4.54 | 5.37 | 6.00 | 0.50 | 15.08 |
| | YES | 2.31 | 0.38 | 6.00 | 1.88 | 2.89 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE E-10. COMPARISON OF BENZOFLUORANTHENE LEVELS ($ng/m^3$) FOR HOMES HAVING WOODBURNING FIREPLACES IN USE AND HOMES NOT HAVING WOODBURNING FIREPLACES IN USE.

| | | BENZOFLUORANTHENES | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N[a] | MIN[a] | MAX [a] |
| LOCATION | WOOD BURNING | | | | | |
| KITCHEN | NO | 1.91 | 1.93 | 8.00 | 0.18 | 5.60 |
| | YES | 1.97 | 0.88 | 8.00 | 1.04 | 3.39 |
| LIVING ROOM | NO | 2.37 | 1.92 | 7.00 | 0.59 | 5.87 |
| | YES | 3.07 | 2.46 | 8.00 | 1.15 | 7.81 |
| BEDROOM | NO | 1.64 | 1.55 | 6.00 | 0.00 | 4.10 |
| | YES | 1.27 | 0.30 | 6.00 | 0.94 | 1.88 |
| OUTDOOR | NO | 5.62 | 6.32 | 8.00 | 0.35 | 17.74 |
| | YES | 2.84 | 0.56 | 6.00 | 2.09 | 3.41 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE E-11. COMPARISON OF BENZO(e)PYRENE LEVELS (ng/m$^3$) FOR HOMES HAVING WOODBURNING FIREPLACES IN USE AND HOMES NOT HAVING WOODBURNING FIREPLACES IN USE.

| | | BENZO(E)PYRENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N[a] | MIN[a] | MAX [a] |
| LOCATION | WOOD BURNING | | | | | |
| KITCHEN | NO | 0.93 | 0.74 | 6.00 | 0.00 | 2.06 |
| | YES | 1.29 | 0.62 | 6.00 | 0.81 | 2.24 |
| LIVING ROOM | NO | 1.24 | 0.91 | 7.00 | 0.31 | 2.76 |
| | YES | 1.60 | 1.12 | 8.00 | 0.64 | 3.57 |
| BEDROOM | NO | 0.95 | 0.80 | 6.00 | 0.00 | 2.10 |
| | YES | 0.64 | 0.19 | 6.00 | 0.54 | 1.06 |
| OUTDOOR | NO | 3.05 | 3.13 | 6.00 | 0.29 | 9.01 |
| | YES | 1.52 | 0.38 | 6.00 | 1.09 | 2.05 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE E-12. COMPARISON OF INDENO(1,2,3-c,d)PYRENE LEVELS (ng/$m^3$) FOR HOMES HAVING WOODBURNING FIREPLACES IN USE AND HOMES NOT HAVING WOODBURNING FIREPLACES IN USE.

| | | INDENO(1,2,3-C,D)PYRENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N[a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | | | | | |
| KITCHEN | NO | 0.95 | 0.86 | 8.00 | 0.00 | 2.37 |
| | YES | 1.17 | 0.74 | 6.00 | 0.59 | 2.60 |
| LIVING ROOM | NO | 1.27 | 0.99 | 7.00 | 0.30 | 3.00 |
| | YES | 1.26 | 0.91 | 8.00 | 0.48 | 2.75 |
| BEDROOM | NO | 1.29 | 1.36 | 6.00 | 0.00 | 3.53 |
| | YES | 0.70 | 0.21 | 6.00 | 0.48 | 0.99 |
| OUTDOOR | NO | 2.61 | 3.03 | 6.00 | 0.18 | 8.43 |
| | YES | 1.12 | 0.27 | 6.00 | 0.89 | 1.65 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE E-13. COMPARISON OF BENZO(g,h,i)PERYLENE LEVELS ($ng.m^3$) FOR HOMES HAVING WOODBURNING FIREPLACES IN USE AND HOMES NOT HAVING WOODBURNING FIREPLACES IN USE.

| | | BENZO(G,H,I)PERYLENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD[a] | N[a] | MIN[a] | MAX[a] |
| LOCATION | WOOD BURNING | | | | | |
| KITCHEN | NO | 1.44 | 0.98 | 8.00 | 0.00 | 2.80 |
| | YES | 1.78 | 0.93 | 8.00 | 0.98 | 3.15 |
| LIVING ROOM | NO | 1.59 | 0.87 | 7.00 | 0.45 | 2.85 |
| | YES | 1.53 | 0.89 | 8.00 | 0.57 | 2.83 |
| BEDROOM | NO | 2.04 | 2.02 | 8.00 | 0.00 | 5.40 |
| | YES | 0.88 | 0.15 | 8.00 | 0.72 | 1.08 |
| OUTDOOR | NO | 4.37 | 4.54 | 8.00 | 0.29 | 12.88 |
| | YES | 2.11 | 0.92 | 8.00 | 1.34 | 3.82 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE E-14. COMPARISON OF CORONENE LEVELS (ng/m$^3$) FOR HOMES HAVING WOODBURNING FIREPLACES IN USE AND H OMES NOT HAVING WOODBURNING FIREPLACES IN USE.

| | | CORONENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD[a] | N[a] | MIN[a] | MAX[a] |
| LOCATION | WOOD BURNING | | | | | |
| KITCHEN | NO | 1.27 | 0.93 | 6.00 | 0.00 | 2.10 |
| | YES | 1.37 | 0.97 | 6.00 | 0.58 | 3.08 |
| LIVING ROOM | NO | 1.09 | 0.82 | 7.00 | 0.00 | 2.50 |
| | YES | 0.73 | 0.35 | 8.00 | 0.30 | 1.19 |
| BEDROOM | NO | 1.55 | 1.93 | 6.00 | 0.00 | 4.75 |
| | YES | 0.53 | 0.19 | 6.00 | 0.30 | 0.82 |
| OUTDOOR | NO | 2.59 | 2.57 | 6.00 | 0.22 | 7.13 |
| | YES | 1.23 | 0.58 | 6.00 | 0.85 | 2.39 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE E-15. COMPARISON OF 2-NITROFLUORANTHENE LEVELS ($ng/m^3$) FOR HOMES HAVING WOODBURNING FIREPLACES IN USE AND HOMES NOT HAVING WOODBURNING FIREPLACES IN USE.

| | | 2-NITROFLUORANTHENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N[a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | | | | | |
| INDOOR, COMB | NO | 0.066 | 0.060 | 8 | 0.008 | 0.143 |
| | YES | 0.055 | 0.023 | 6 | 0.028 | 0.087 |
| OUTDOOR | NO | 0.072 | 0.065 | 6 | 0.005 | 0.168 |
| | YES | 0.113 | 0.067 | 6 | 0.028 | 0.185 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration

# APPENDIX F

# COMPARISON OF PAH CONCENTRATIONS (ng/m$^3$) FOR HOMES HAVING CIGARETTE SMOKERS AND HOMES NOT HAVING SMOKERS: ALL OTHER TARGET COMPOUNDS

TABLE F-1. COMPARISON OF QUINOLINE LEVELS (ng/m$^3$) FOR HOMES HAVING CIGARETTE SMOKERS AND HOMES NOT HAVING SMOKERS.

|  |  | QUINOLINE |  |  |  |  |
|---|---|---|---|---|---|---|
|  |  | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | SMOKING |  |  |  |  |  |
| KITCHEN | NO | 1.69 | 1.34 | 7.00 | 0.29 | 4.50 |
|  | YES | 10.47 | 2.19 | 5.00 | 8.09 | 13.78 |
| LIVING ROOM | NO | 2.85 | 3.43 | 9.00 | 0.51 | 11.67 |
|  | YES | 19.26 | 12.63 | 6.00 | 6.26 | 37.04 |
| BEDROOM | NO | 2.21 | 2.51 | 7.00 | 0.33 | 7.88 |
|  | YES | 8.26 | 3.12 | 5.00 | 4.10 | 11.40 |
| OUTDOOR | NO | 0.49 | 0.52 | 7.00 | 0.11 | 1.82 |
|  | YES | 0.89 | 0.69 | 5.00 | 0.27 | 2.03 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE F-2. COMPARISON OF ISOQUINOLINE LEVELS ($ng/m^3$) FOR HOMES HAVING CIGARETTE SMOKERS AND HOMES NOT HAVING SMOKERS.

| | | ISOQUINOLINE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | SMOKING | | | | | |
| KITCHEN | NO | 2.90 | 5.58 | 7.00 | 0.57 | 15.50 |
| | YES | 11.88 | 16.12 | 5.00 | 4.41 | 40.71 |
| LIVING ROOM | NO | 1.64 | 1.84 | 9.00 | 0.52 | 6.47 |
| | YES | 10.63 | 7.55 | 6.00 | 3.09 | 23.50 |
| BEDROOM | NO | 1.19 | 0.67 | 7.00 | 0.43 | 2.19 |
| | YES | 18.02 | 25.53 | 5.00 | 3.35 | 63.18 |
| OUTDOOR | NO | 0.41 | 0.38 | 7.00 | 0.15 | 1.19 |
| | YES | 1.35 | 0.45 | 5.00 | 0.67 | 1.75 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE F-3. COMPARISON OF PHENANTHRENE LEVELS ($ng/m^3$) FOR HOMES HAVING CIGARETTE SMOKERS AND HOMES NOT HAVING SMOKERS.

| | | PHENANTHRENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | SMOKING | | | | | |
| KITCHEN | NO | 57.76 | 19.05 | 7.00 | 34.54 | 88.09 |
| | YES | 98.85 | 33.85 | 5.00 | 60.61 | 143.58 |
| LIVING ROOM | NO | 65.73 | 16.88 | 9.00 | 33.77 | 86.52 |
| | YES | 107.20 | 23.93 | 6.00 | 70.97 | 132.33 |
| BEDROOM | NO | 50.92 | 14.11 | 7.00 | 24.13 | 67.44 |
| | YES | 93.24 | 23.26 | 5.00 | 62.16 | 116.81 |
| OUTDOOR | NO | 31.56 | 11.19 | 7.00 | 10.10 | 46.45 |
| | YES | 49.81 | 17.60 | 5.00 | 31.17 | 75.13 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE F-4. COMPARISON OF ANTHRACENE LEVELS (ng/m$^3$) FOR HOMES HAVING CIGARETTE SMOKERS AND HOMES NOT HAVING SMOKERS.

| | | ANTHRACENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN[a] | MAX[a] |
| LOCATION | SMOKING | | | | | |
| KITCHEN | NO | 12.75 | 26.42 | 7.00 | 1.48 | 72.83 |
| | YES | 6.71 | 3.75 | 5.00 | 3.78 | 13.25 |
| LIVING ROOM | NO | 4.09 | 2.35 | 9.00 | 1.48 | 8.19 |
| | YES | 8.34 | 2.05 | 6.00 | 5.82 | 10.91 |
| BEDROOM | NO | 2.55 | 0.87 | 7.00 | 1.32 | 3.39 |
| | YES | 5.95 | 1.78 | 5.00 | 3.87 | 7.77 |
| OUTDOOR | NO | 2.28 | 1.46 | 7.00 | 0.58 | 4.20 |
| | YES | 3.66 | 1.78 | 5.00 | 2.10 | 6.41 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE F-5. COMPARISON OF FLUORANTHENE LEVELS (ng/m$^3$) FOR HOMES HAVING CIGARETTE SMOKERS AND HOMES NOT HAVING SMOKERS.

| | | FLUORANTHENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD[a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | SMOKING | | | | | |
| KITCHEN | NO | 14.45 | 4.89 | 7.00 | 9.23 | 22.64 |
| | YES | 21.37 | 4.82 | 5.00 | 14.31 | 26.37 |
| LIVING ROOM | NO | 19.12 | 4.75 | 9.00 | 9.94 | 25.17 |
| | YES | 28.16 | 7.59 | 6.00 | 18.56 | 37.37 |
| BEDROOM | NO | 12.80 | 4.76 | 7.00 | 5.11 | 18.31 |
| | YES | 19.49 | 3.91 | 5.00 | 13.31 | 22.66 |
| OUTDOOR | NO | 11.75 | 3.97 | 7.00 | 4.75 | 18.35 |
| | YES | 21.03 | 10.68 | 5.00 | 13.74 | 39.49 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE F-6. COMPARISON OF PYRENE LEVELS ($ng/m^3$) FOR HOMES HAVING CIGARETTE SMOKERS AND HOMES NOT HAVING SMOKERS.

| | | PYRENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | SMOKING | | | | | |
| KITCHEN | NO | 6.90 | 2.03 | 7.00 | 4.79 | 10.48 |
| | YES | 9.56 | 2.97 | 5.00 | 5.46 | 13.25 |
| LIVING ROOM | NO | 8.55 | 2.43 | 9.00 | 4.30 | 11.17 |
| | YES | 13.15 | 3.47 | 6.00 | 7.96 | 18.10 |
| BEDROOM | NO | 5.59 | 1.82 | 7.00 | 2.67 | 8.23 |
| | YES | 8.92 | 1.86 | 5.00 | 6.83 | 10.86 |
| OUTDOOR | NO | 6.74 | 3.26 | 7.00 | 2.54 | 13.11 |
| | YES | 12.83 | 8.19 | 5.00 | 7.28 | 26.93 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE F-7. COMPARISON OF CYCLOPENTA(c,d)PYRENE LEVELS (ng/m$^3$) FOR HOMES HAVING CIGARETTE SMOKERS AND HOMES NOT HAVING SMOKERS.

| | | CYCLOPENTA(C,D)PYRENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | SMOKING | | | | | |
| KITCHEN | NO | 0.36 | 0.31 | 7.00 | 0.00 | 0.80 |
| | YES | 0.97 | 0.68 | 5.00 | 0.34 | 1.72 |
| LIVING ROOM | NO | 0.35 | 0.29 | 9.00 | 0.00 | 0.92 |
| | YES | 1.04 | 0.81 | 6.00 | 0.35 | 2.38 |
| BEDROOM | NO | 0.35 | 0.44 | 7.00 | 0.00 | 1.21 |
| | YES | 0.50 | 0.56 | 5.00 | 0.00 | 1.45 |
| OUTDOOR | NO | 0.81 | 1.32 | 7.00 | 0.07 | 3.74 |
| | YES | 0.91 | 1.03 | 5.00 | 0.23 | 2.72 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE F-8. COMPARISON OF BENZ(a)ANTHRACENE LEVELS (ng/m$^3$) FOR HOMES HAVING CIGARETTE SMOKERS AND HOMES NOT HAVING SMOKERS.

| | | BENZ(A)ANTHRACENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | SMOKING | | | | | |
| KITCHEN | NO | 0.66 | 0.35 | 7.00 | 0.26 | 1.16 |
| | YES | 1.69 | 0.97 | 5.00 | 0.74 | 2.77 |
| LIVING ROOM | NO | 0.62 | 0.22 | 9.00 | 0.30 | 0.96 |
| | YES | 2.22 | 0.90 | 8.00 | 1.25 | 3.81 |
| BEDROOM | NO | 0.40 | 0.25 | 7.00 | 0.00 | 0.78 |
| | YES | 0.95 | 0.21 | 5.00 | 0.73 | 1.24 |
| OUTDOOR | NO | 1.22 | 1.08 | 7.00 | 0.23 | 2.77 |
| | YES | 3.03 | 3.74 | 5.00 | 1.11 | 9.71 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE F-9. COMPARISON OF CHRYSENE LEVELS ($ng/m^3$) FOR HOMES HAVING CIGARETTE SMOKERS AND HOMES NOT HAVING SMOKERS.

| | | CHRYSENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | SMOKING | | | | | |
| KITCHEN | NO | 1.12 | 0.38 | 7.00 | 0.57 | 1.49 |
| | YES | 3.54 | 2.44 | 5.00 | 1.45 | 7.35 |
| LIVING ROOM | NO | 1.24 | 0.42 | 9.00 | 0.67 | 1.92 |
| | YES | 4.83 | 2.14 | 6.00 | 2.48 | 8.61 |
| BEDROOM | NO | 0.84 | 0.25 | 7.00 | 0.41 | 1.08 |
| | YES | 1.86 | 0.15 | 5.00 | 1.72 | 2.03 |
| OUTDOOR | NO | 2.20 | 1.34 | 7.00 | 0.50 | 4.01 |
| | YES | 5.14 | 5.58 | 5.00 | 2.43 | 15.08 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE F-10. COMPARISON OF BENZOFLUORANTHENE LEVELS ($ng/m^3$) FOR HOMES HAVING CIGARETTE SMOKERS AND HOMES NOT HAVING SMOKERS.

| | | BENZOFLUORANTHENES | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | SMOKING | | | | | |
| KITCHEN | NO | 1.21 | 0.63 | 7.00 | 0.18 | 1.75 |
| | YES | 2.97 | 1.66 | 5.00 | 1.51 | 5.60 |
| LIVING ROOM | NO | 1.35 | 0.53 | 9.00 | 0.59 | 2.13 |
| | YES | 4.82 | 2.03 | 6.00 | 2.52 | 7.81 |
| BEDROOM | NO | 0.92 | 0.69 | 7.00 | 0.00 | 2.15 |
| | YES | 2.20 | 1.14 | 5.00 | 1.26 | 4.10 |
| OUTDOOR | NO | 2.80 | 2.02 | 7.00 | 0.35 | 6.00 |
| | YES | 6.22 | 6.44 | 5.00 | 3.00 | 17.74 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE F-11. COMPARISON OF BENZO(e)PYRENE LEVELS (ng/m$^3$) FOR HOMES HAVING CIGARETTE SMOKERS AND HOMES NOT HAVING SMOKERS.

| | | BENZO(E)PYRENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | SMOKING | | | | | |
| KITCHEN | NO | 0.71 | 0.42 | 7.00 | 0.00 | 1.03 |
| | YES | 1.67 | 0.57 | 5.00 | 0.90 | 2.24 |
| LIVING ROOM | NO | 0.77 | 0.29 | 9.00 | 0.31 | 1.07 |
| | YES | 2.42 | 0.89 | 6.00 | 1.31 | 3.57 |
| BEDROOM | NO | 0.68 | 0.46 | 7.00 | 0.00 | 1.28 |
| | YES | 1.22 | 0.55 | 5.00 | 0.72 | 2.10 |
| OUTDOOR | NO | 1.52 | 1.06 | 7.00 | 0.29 | 3.08 |
| | YES | 3.36 | 3.17 | 5.00 | 1.59 | 9.01 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE F-12. COMPARISON OF INDENO(1,2,3,-c,d)PYRENE LEVELS (ng/m$^3$) FOR HOMES HAVING CIGARETTE SMOKERS AND HOMES NOT HAVING SMOKERS.

| | | INDENO(1,2,3-C,D)PYRENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | SMOKING | | | | | |
| KITCHEN | NO | 0.58 | 0.38 | 7.00 | 0.00 | 0.90 |
| | YES | 1.73 | 0.70 | 5.00 | 1.13 | 2.60 |
| LIVING ROOM | NO | 0.66 | 0.24 | 9.00 | 0.30 | 1.04 |
| | YES | 2.17 | 0.78 | 8.00 | 1.21 | 3.00 |
| BEDROOM | NO | 0.60 | 0.66 | 7.00 | 0.00 | 1.97 |
| | YES | 1.55 | 1.15 | 5.00 | 0.81 | 3.53 |
| OUTDOOR | NO | 1.23 | 0.98 | 7.00 | 0.18 | 2.69 |
| | YES | 2.75 | 3.18 | 5.00 | 1.07 | 8.43 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE F-13. COMPARISON OF BENZO(g,h,i)PERYLENE LEVELS (ng/m$^3$) FOR HOMES HAVING CIGARETTE SMOKERS AND HOMES NOT HAVING SMOKERS.

| | | BENZO(G,H,I)PERYLENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | SMOKING | | | | | |
| KITCHEN | NO | 1.06 | 0.86 | 7.00 | 0.00 | 1.79 |
| | YES | 2.37 | 0.70 | 5.00 | 1.35 | 3.15 |
| LIVING ROOM | NO | 1.10 | 0.71 | 9.00 | 0.45 | 2.65 |
| | YES | 2.24 | 0.52 | 6.00 | 1.50 | 2.83 |
| BEDROOM | NO | 1.02 | 1.06 | 7.00 | 0.00 | 3.20 |
| | YES | 2.07 | 1.91 | 5.00 | 0.95 | 5.40 |
| OUTDOOR | NO | 2.20 | 1.93 | 7.00 | 0.29 | 5.10 |
| | YES | 4.69 | 4.53 | 5.00 | 1.72 | 12.68 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

## TABLE F-14. COMPARISON OF CORONENE LEVELS ($ng/m^3$) FOR HOMES HAVING CIGARETTE SMOKERS AND HOMES NOT HAVING SMOKERS.

| | | CORONENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | SMOKING | | | | | |
| KITCHEN | NO | 0.81 | 0.63 | 7.00 | 0.00 | 1.67 |
| | YES | 2.02 | 0.77 | 5.00 | 0.92 | 3.08 |
| LIVING ROOM | NO | 0.76 | 0.77 | 9.00 | 0.00 | 2.50 |
| | YES | 1.10 | 0.18 | 6.00 | 0.90 | 1.38 |
| BEDROOM | NO | 0.84 | 1.02 | 7.00 | 0.00 | 3.00 |
| | YES | 1.32 | 1.94 | 5.00 | 0.10 | 4.75 |
| OUTDOOR | NO | 1.40 | 1.25 | 7.00 | 0.22 | 3.60 |
| | YES | 2.63 | 2.57 | 5.00 | 0.85 | 7.13 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE F-15. COMPARISON OF 2-NITROFLUORANTHENE LEVELS ($ng/m^3$) FOR HOMES HAVING CIGARETTE SMOKERS AND HOMES NOT HAVING SMOKERS.

| | | 2-NITROFLUORANTHENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD[a] | N[a] | MIN [a] | MAX [a] |
| LOCATION | SMOKING | | | | | |
| INDOOR, COMB | NO | 0.034 | 0.022 | 7 | 0.008 | 0.087 |
| | YES | 0.098 | 0.039 | 5 | 0.055 | 0.143 |
| OUTDOOR | NO | 0.068 | 0.061 | 7 | 0.005 | 0.185 |
| | YES | 0.129 | 0.080 | 5 | 0.028 | 0.168 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

# APPENDIX G

## COMPARISON OF PAH CONCENTRATIONS (ng/m$^3$) FOR GAS-HEATED HOMES AND ELECTRICALLY HEATED HOMES: ALL OTHER TARGET COMPOUNDS

TABLE G-1. COMPARISON OF QUINOLINE LEVELS (ng/m$^3$) FOR GAS-HEATED HOMES AND ELECTRICALLY HEATED HOMES.

| | | QUINOLINE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | HEATING SYSTEM | | | | | |
| KITCHEN | GAS | 5.85 | 5.11 | 10.00 | 0.29 | 13.78 |
| | ELECTRIC | 2.86 | 2.32 | 2.00 | 1.22 | 4.50 |
| LIVING ROOM | GAS | 10.74 | 11.87 | 13.00 | 1.34 | 37.04 |
| | ELECTRIC | 0.85 | 0.47 | 2.00 | 0.51 | 1.18 |
| BEDROOM | GAS | 5.56 | 3.97 | 10.00 | 1.14 | 11.40 |
| | ELECTRIC | 0.56 | 0.32 | 2.00 | 0.33 | 0.78 |
| OUTDOOR | GAS | 0.58 | 0.58 | 10.00 | 0.11 | 2.03 |
| | ELECTRIC | 1.07 | 0.79 | 2.00 | 0.51 | 1.62 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE G-2. COMPARISON OF ISOQUINOLINE LEVELS ($ng/m^3$) FOR GAS-HEATED HOMES AND ELECTRICALLY HEATED HOMES.

| | | ISOQUINOLINE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | HEATING SYSTEM | | | | | |
| KITCHEN | GAS | 7.85 | 12.35 | 10.00 | 0.89 | 40.71 |
| | ELECTRIC | 0.82 | 0.06 | 2.00 | 0.57 | 0.66 |
| LIVING ROOM | GAS | 5.93 | 6.81 | 13.00 | 0.88 | 23.50 |
| | ELECTRIC | 0.73 | 0.30 | 2.00 | 0.52 | 0.94 |
| BEDROOM | GAS | 9.54 | 19.23 | 10.00 | 0.43 | 63.18 |
| | ELECTRIC | 1.52 | 0.95 | 2.00 | 0.85 | 2.19 |
| OUTDOOR | GAS | 0.80 | 0.68 | 10.00 | 0.15 | 1.75 |
| | ELECTRIC | 0.80 | 0.55 | 2.00 | 0.42 | 1.19 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE G-3. COMPARISON OF PHENANTHRENE LEVELS (ng/$m^3$) FOR GAS-HEATED HOMES AND ELECTRICALLY HEATED HOMES.

| LOCATION | HEATING SYSTEM | PHENANTHRENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| KITCHEN | GAS | 82.24 | 30.57 | 10.00 | 49.25 | 143.58 |
| | ELECTRIC | 38.09 | 5.01 | 2.00 | 34.54 | 41.63 |
| LIVING ROOM | GAS | 88.47 | 25.00 | 13.00 | 60.37 | 132.33 |
| | ELECTRIC | 42.36 | 12.14 | 2.00 | 33.77 | 50.94 |
| BEDROOM | GAS | 74.82 | 25.56 | 10.00 | 42.61 | 116.81 |
| | ELECTRIC | 37.20 | 18.49 | 2.00 | 24.13 | 50.28 |
| OUTDOOR | GAS | 42.62 | 14.78 | 10.00 | 26.57 | 75.13 |
| | ELECTRIC | 21.97 | 16.79 | 2.00 | 10.10 | 33.84 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE G-4. COMPARISON OF ANTHRACENE LEVELS ($ng/m^3$) FOR GAS-HEATED HOMES AND ELECTRICALLY HEATED HOMES.

| | | ANTHRACENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | HEATING SYSTEM | | | | | |
| KITCHEN | GAS | 11.84 | 21.59 | 10.00 | 2.14 | 72.63 |
| | ELECTRIC | 2.18 | 0.98 | 2.00 | 1.48 | 2.87 |
| LIVING ROOM | GAS | 6.36 | 2.86 | 13.00 | 2.50 | 10.91 |
| | ELECTRIC | 2.10 | 0.89 | 2.00 | 1.48 | 2.73 |
| BEDROOM | GAS | 4.29 | 2.12 | 10.00 | 2.27 | 7.77 |
| | ELECTRIC | 2.35 | 1.46 | 2.00 | 1.32 | 3.39 |
| OUTDOOR | GAS | 3.23 | 1.57 | 10.00 | 1.20 | 6.41 |
| | ELECTRIC | 0.97 | 0.55 | 2.00 | 0.58 | 1.36 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest ovserved concentration

TABLE G-5. COMPARISON OF FLUORANTHENE LEVELS ($ng/m^3$) FOR GAS-HEATED HOMES AND ELECTRICALLY HEATED HOMES.

| | | FLUORANTHENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | HEATING SYSTEM | | | | | |
| KITCHEN | GAS | 18.90 | 4.91 | 10.00 | 12.98 | 26.37 |
| | ELECTRIC | 9.50 | 0.38 | 2.00 | 9.23 | 9.77 |
| LIVING ROOM | GAS | 24.33 | 6.47 | 13.00 | 16.73 | 37.37 |
| | ELECTRIC | 12.38 | 3.43 | 2.00 | 9.94 | 14.79 |
| BEDROOM | GAS | 16.86 | 4.68 | 10.00 | 8.87 | 22.68 |
| | ELECTRIC | 9.25 | 5.85 | 2.00 | 5.11 | 13.39 |
| OUTDOOR | GAS | 17.20 | 8.39 | 10.00 | 11.95 | 39.49 |
| | ELECTRIC | 7.69 | 4.17 | 2.00 | 4.75 | 10.64 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE G-6. COMPARISON OF PYRENE LEVELS (ng/m$^3$) FOR GAS-HEATED HOMES AND ELECTRICALLY HEATED HOMES.

| | | PYRENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | HEATING SYSTEM | | | | | |
| KITCHEN | GAS | 8.62 | 2.55 | 10.00 | 5.46 | 13.25 |
| | ELECTRIC | 4.97 | 0.25 | 2.00 | 4.79 | 5.15 |
| LIVING ROOM | GAS | 11.20 | 3.14 | 13.00 | 7.28 | 18.10 |
| | ELECTRIC | 5.10 | 1.13 | 2.00 | 4.30 | 5.90 |
| BEDROOM | GAS | 7.55 | 2.16 | 10.00 | 4.37 | 10.86 |
| | ELECTRIC | 4.10 | 2.01 | 2.00 | 2.67 | 5.52 |
| OUTDOOR | GAS | 10.39 | 6.35 | 10.00 | 5.84 | 26.93 |
| | ELECTRIC | 3.71 | 1.66 | 2.00 | 2.54 | 4.89 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE G-7. COMPARISON OF CYCLOPENTA(c,d)PYRENE LEVELS (ng/$m^3$) FOR GAS-HEATED HOMES AND ELECTRICALLY HEATED HOMES.

| | | CYCLOPENTA(C,D)PYRENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | HEATING SYSTEM | | | | | |
| KITCHEN | GAS | 0.71 | 0.57 | 10.00 | 0.00 | 1.72 |
| | ELECTRIC | 0.16 | 0.23 | 2.00 | 0.00 | 0.33 |
| LIVING ROOM | GAS | 0.71 | 0.84 | 13.00 | 0.15 | 2.38 |
| | ELECTRIC | 0.11 | 0.15 | 2.00 | 0.00 | 0.22 |
| BEDROOM | GAS | 0.49 | 0.48 | 10.00 | 0.00 | 1.45 |
| | ELECTRIC | 0.00 | 0.00 | 2.00 | 0.00 | 0.00 |
| OUTDOOR | GAS | 1.00 | 1.22 | 10.00 | 0.10 | 3.74 |
| | ELECTRIC | 0.11 | 0.06 | 2.00 | 0.07 | 0.15 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE G-8. COMPARISON OF BENZ(a)ANTHRACENE LEVELS (ng/m$^3$) FOR GAS-HEATED HOMES AND ELECTRICALLY HEATED HOMES.

| | | BENZ(A)ANTHRACENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | HEATING SYSTEM | | | | | |
| KITCHEN | GAS | 1.25 | 0.81 | 10.00 | 0.44 | 2.77 |
| | ELECTRIC | 0.28 | 0.03 | 2.00 | 0.26 | 0.30 |
| LIVING ROOM | GAS | 1.37 | 1.02 | 13.00 | 0.30 | 3.81 |
| | ELECTRIC | 0.56 | 0.35 | 2.00 | 0.31 | 0.81 |
| BEDROOM | GAS | 0.73 | 0.28 | 10.00 | 0.38 | 1.24 |
| | ELECTRIC | 0.10 | 0.14 | 2.00 | 0.00 | 0.19 |
| OUTDOOR | GAS | 2.33 | 2.69 | 10.00 | 0.67 | 9.71 |
| | ELECTRIC | 0.23 | 0.00 | 2.00 | 0.23 | 0.23 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

## TABLE G-9. COMPARISON OF CHYRSENE LEVELS (ng/m$^3$) FOR GAS-HEATED HOMES AND ELECTRICALLY HEATED HOMES.

| | | CHRYSENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N[a] | MIN [a] | MAX [a] |
| LOCATION | HEATING SYSTEM | | | | | |
| KITCHEN | GAS | 2.43 | 2.00 | 10.00 | 1.09 | 7.35 |
| | ELECTRIC | 0.59 | 0.03 | 2.00 | 0.57 | 0.61 |
| LIVING ROOM | GAS | 2.96 | 2.29 | 13.00 | 0.67 | 8.61 |
| | ELECTRIC | 0.81 | 0.18 | 2.00 | 0.68 | 0.94 |
| BEDROOM | GAS | 1.42 | 0.48 | 10.00 | 0.92 | 2.03 |
| | ELECTRIC | 0.50 | 0.13 | 2.00 | 0.41 | 0.59 |
| OUTDOOR | GAS | 3.96 | 3.97 | 10.00 | 1.88 | 15.08 |
| | ELECTRIC | 0.73 | 0.33 | 2.00 | 0.50 | 0.97 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE G-10. COMPARISON OF BENZOFLUORANTHENE LEVELS (ng/m$^3$) FOR GAS-HEATED HOMES AND ELECTRICALLY HEAATED HOMES.

| | | BENZOFLUORANTHENES | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | HEATING SYSTEM | | | | | |
| KITCHEN | GAS | 2.25 | 1.35 | 10.00 | 1.04 | 5.60 |
| | ELECTRIC | 0.37 | 0.26 | 2.00 | 0.18 | 0.55 |
| LIVING ROOM | GAS | 3.07 | 2.15 | 13.00 | 1.15 | 7.61 |
| | ELECTRIC | 0.60 | 0.01 | 2.00 | 0.59 | 0.61 |
| BEDROOM | GAS | 1.72 | 0.98 | 10.00 | 0.93 | 4.10 |
| | ELECTRIC | 0.13 | 0.18 | 2.00 | 0.00 | 0.25 |
| OUTDOOR | GAS | 4.93 | 4.65 | 10.00 | 2.09 | 17.74 |
| | ELECTRIC | 0.73 | 0.53 | 2.00 | 0.35 | 1.10 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE G-11. COMPARISON OF BENZO(e)PYRENE LEVELS (ng/m$^3$) FOR GAS-HEATED HOMES AND ELECTRICALLY HEATED HOMES.

| | | BENZO(E)PYRENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | HEATING SYSTEM | | | | | |
| KITCHEN | GAS | 1.31 | 0.55 | 10.00 | 0.81 | 2.24 |
| | ELECTRIC | 0.12 | 0.17 | 2.00 | 0.00 | 0.24 |
| LIVING ROOM | GAS | 1.80 | 0.98 | 13.00 | 0.64 | 3.57 |
| | ELECTRIC | 0.33 | 0.03 | 2.00 | 0.31 | 0.35 |
| BEDROOM | GAS | 1.05 | 0.45 | 10.00 | 0.54 | 2.10 |
| | ELECTRIC | 0.10 | 0.14 | 2.00 | 0.00 | 0.19 |
| OUTDOOR | GAS | 2.84 | 2.34 | 10.00 | 1.09 | 9.01 |
| | ELECTRIC | 0.52 | 0.32 | 2.00 | 0.29 | 0.74 |

[a] Std is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE G-12. COMPARISON OF INDENO(1,2,3-c,d) PYRENE LEVELS (ng/m$^3$) FOR GAS-HEATED HOMES AND ELECTRICALLY HEATAED HOMES.

| | | INDENO(1,2,3-C,D)PYRENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | HEATING SYSTEM | | | | | |
| KITCHEN | GAS | 1.25 | 0.69 | 10.00 | 0.59 | 2.60 |
| | ELECTRIC | 0.08 | 0.11 | 2.00 | 0.00 | 0.16 |
| LIVING ROOM | GAS | 1.40 | 0.91 | 13.00 | 0.48 | 3.00 |
| | ELECTRIC | 0.39 | 0.14 | 2.00 | 0.30 | 0.49 |
| BEDROOM | GAS | 1.20 | 0.95 | 10.00 | 0.48 | 3.53 |
| | ELECTRIC | 0.00 | 0.00 | 2.00 | 0.00 | 0.00 |
| OUTDOOR | GAS | 2.18 | 2.28 | 10.00 | 0.89 | 8.43 |
| | ELECTRIC | 0.28 | 0.13 | 2.00 | 0.18 | 0.37 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE G-13. COMPARISON OF BENZO(g,h,i)PERYLENE LEVELS (ng/m$^3$) FOR GAS-HEATED HOMES AND ELECTRICALLY HEATED HOMES.

| | | BENZO(G,H,I)PERYLENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | HEATING SYSTEM | | | | | |
| KITCHEN | GAS | 1.88 | 0.74 | 10.00 | 0.98 | 3.15 |
| | ELECTRIC | 0.25 | 0.35 | 2.00 | 0.00 | 0.49 |
| LIVING ROOM | GAS | 1.72 | 0.78 | 13.00 | 0.57 | 2.83 |
| | ELECTRIC | 0.47 | 0.02 | 2.00 | 0.45 | 0.48 |
| BEDROOM | GAS | 1.72 | 1.50 | 10.00 | 0.72 | 5.40 |
| | ELECTRIC | 0.14 | 0.19 | 2.00 | 0.00 | 0.27 |
| OUTDOOR | GAS | 3.79 | 3.40 | 10.00 | 1.34 | 12.66 |
| | ELECTRIC | 0.46 | 0.24 | 2.00 | 0.29 | 0.84 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE G-14. COMPARISON OF CORONENE LEVELS (ng/m$^3$) FOR GAS-HEATED HOMES AND ELECTRICALLY HEATED HOMES.

| | | CORONENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | HEATING SYSTEM | | | | | |
| KITCHEN | GAS | 1.58 | 0.78 | 10.00 | 0.58 | 2.08 |
| | ELECTRIC | 0.11 | 0.15 | 2.00 | 0.00 | 0.22 |
| LIVING ROOM | GAS | 1.01 | 0.57 | 13.00 | 0.30 | 2.50 |
| | ELECTRIC | 0.14 | 0.20 | 2.00 | 0.00 | 0.28 |
| BEDROOM | GAS | 1.23 | 1.49 | 10.00 | 0.10 | 4.75 |
| | ELECTRIC | 0.12 | 0.16 | 2.00 | 0.00 | 0.23 |
| OUTDOOR | GAS | 2.23 | 1.95 | 10.00 | 0.85 | 7.13 |
| | ELECTRIC | 0.31 | 0.13 | 2.00 | 0.22 | 0.40 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration; and MAX is the highest observed concentration.

TABLE G-15. COMPARISON OF 2-NITROFLUORANTHENE LEVELS (ng/m$^3$) FOR GAS-HEATED HOMES AND ELECTRICALLY HEATED HOMES.

| | | 2-NITROFLUORANTHENE | | | | |
|---|---|---|---|---|---|---|
| | | MEAN | STD [a] | N[a] | MIN[a] | MAX[a] |
| LOCATION | HEATING SYSTEM | | | | | |
| INDOOR,COMB | GAS | 0.065 | 0.044 | 10 | 0.013 | 0.143 |
| | ELECTRIC | 0.037 | 0.042 | 2 | 0.008 | 0.067 |
| OUTDOOR | GAS | 0.110 | 0.058 | 10 | 0.028 | 0.185 |
| | ELECTRIC | 0.005 | 0.001 | 2 | 0.005 | 0.006 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

# APPENDIX H

# SUMMARY OF PAH CONCENTRATIONS ($ng/m^3$) FOR THE DIFFERENT COMBINATIONS OF EXPERIMENTAL CONDITIONS: ALL OTHER TARGET COMPOUNDS

TABLE H-1. SUMMARY OF QUINOLINE LEVELS (ng/m$^3$) FOR THE DIFFERENT COMBINATIONS OF THE EXPERIMENTAL FACTORS.

HEATING SYSTEM=GAS

|  |  |  | QUINOLINE |  |  |  |  |
|---|---|---|---|---|---|---|---|
|  |  |  | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING |  |  |  |  |  |
| KITCHEN | NO | NO | 1.47 | 0.64 | 2.00 | 1.02 | 1.92 |
|  |  | YES | 9.70 | 1.00 | 2.00 | 8.99 | 10.40 |
|  | YES | NO | 1.05 | 0.68 | 3.00 | 0.29 | 1.51 |
|  |  | YES | 10.99 | 2.85 | 3.00 | 8.09 | 13.78 |
| LIVING ROOM | NO | NO | 5.53 | 5.44 | 3.00 | 1.34 | 11.67 |
|  |  | YES | 26.53 | 14.87 | 2.00 | 16.01 | 37.04 |
|  | YES | NO | 1.85 | 0.65 | 4.00 | 1.45 | 2.82 |
|  |  | YES | 15.63 | 11.81 | 4.00 | 8.26 | 31.23 |
| BEDROOM | NO | NO | 4.41 | 4.62 | 2.00 | 1.14 | 7.68 |
|  |  | YES | 11.35 | 0.06 | 2.00 | 11.31 | 11.40 |
|  | YES | NO | 1.84 | 0.67 | 3.00 | 1.37 | 2.60 |
|  |  | YES | 6.19 | 1.87 | 3.00 | 4.10 | 7.72 |
| OUTDOOR | NO | NO | 0.36 | 0.20 | 2.00 | 0.21 | 0.50 |
|  |  | YES | 1.43 | 0.85 | 2.00 | 0.83 | 2.03 |
|  | YES | NO | 0.19 | 0.09 | 3.00 | 0.11 | 0.28 |
|  |  | YES | 0.54 | 0.31 | 3.00 | 0.27 | 0.88 |

## TABLE H-1. (continued)

**HEATING SYSTEM=ELECTRIC**

| | | | QUINOLINE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 2.86 | 2.32 | 2.00 | 1.22 | 4.50 |
| LIVING ROOM | NO | NO | 0.85 | 0.47 | 2.00 | 0.51 | 1.18 |
| BEDROOM | NO | NO | 0.56 | 0.32 | 2.00 | 0.33 | 0.78 |
| OUTDOOR | NO | NO | 1.07 | 0.79 | 2.00 | 0.51 | 1.62 |

[a] STD is the standard deviation, N is the number of samples, MIN is ithe lowest observed concentration, and MAX is the highest observed concentration.

TABLE H-2. SUMMARY OF ISOQUINOLINE LEVELS (ng/m$^3$) FOR THE DIFFERENT COMBINATIONS OF THE EXPERIMENTAL FACTORS.

HEATING SYSTEM=GAS

| | | | ISOQUINOLINE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 8.19 | 10.35 | 2.00 | 0.87 | 15.50 |
| | | YES | 22.88 | 25.21 | 2.00 | 5.06 | 40.71 |
| | YES | NO | 0.90 | 0.27 | 3.00 | 0.69 | 1.20 |
| | | YES | 4.55 | 0.20 | 3.00 | 4.41 | 4.77 |
| LIVING ROOM | NO | NO | 2.79 | 3.19 | 3.00 | 0.88 | 6.47 |
| | | YES | 16.87 | 9.38 | 2.00 | 10.23 | 23.50 |
| | YES | NO | 1.23 | 0.36 | 4.00 | 0.95 | 1.73 |
| | | YES | 7.51 | 5.17 | 4.00 | 3.09 | 13.63 |
| BEDROOM | NO | NO | 0.67 | 0.33 | 2.00 | 0.43 | 0.90 |
| | | YES | 34.29 | 40.87 | 2.00 | 5.39 | 63.18 |
| | YES | NO | 1.31 | 0.67 | 3.00 | 0.91 | 2.08 |
| | | YES | 7.18 | 5.25 | 3.00 | 3.35 | 13.17 |
| OUTDOOR | NO | NO | 0.38 | 0.29 | 2.00 | 0.18 | 0.59 |
| | | YES | 1.16 | 0.70 | 2.00 | 0.67 | 1.66 |
| | YES | NO | 0.16 | 0.01 | 3.00 | 0.15 | 0.17 |
| | | YES | 1.48 | 0.31 | 3.00 | 1.14 | 1.75 |

## TABLE H-2. (Continued)

**HEATING SYSTEM=ELECTRIC**

| | | | ISOQUINOLINE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 0.62 | 0.08 | 2.00 | 0.57 | 0.68 |
| LIVING ROOM | NO | NO | 0.73 | 0.30 | 2.00 | 0.52 | 0.94 |
| BEDROOM | NO | NO | 1.52 | 0.95 | 2.00 | 0.85 | 2.19 |
| OUTDOOR | NO | NO | 0.80 | 0.55 | 2.00 | 0.42 | 1.19 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE H-3. SUMMARY OF PHENANTHRENE LEVELS (ng/m$^3$) FOR THE DIFFERENT COMBINATIONS OF THE EXPERIMENTAL FACTORS.

HEATING SYSTEM=GAS

| | | | PHENANTHRENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 68.67 | 27.46 | 2.00 | 49.25 | 88.09 |
| | | YES | 65.14 | 6.41 | 2.00 | 60.61 | 69.67 |
| | YES | NO | 63.80 | 11.91 | 3.00 | 55.16 | 77.23 |
| | | YES | 121.32 | 19.41 | 3.00 | 107.90 | 143.58 |
| LIVING ROOM | NO | NO | 67.15 | 6.05 | 3.00 | 60.37 | 72.02 |
| | | YES | 78.00 | 9.95 | 2.00 | 70.97 | 85.04 |
| | YES | NO | 76.36 | 13.00 | 4.00 | 62.49 | 88.52 |
| | | YES | 121.80 | 8.31 | 4.00 | 114.88 | 132.33 |
| BEDROOM | NO | NO | 50.80 | 11.58 | 2.00 | 42.61 | 58.99 |
| | | YES | 68.88 | 9.51 | 2.00 | 62.16 | 75.61 |
| | YES | NO | 60.14 | 6.60 | 3.00 | 54.61 | 67.44 |
| | | YES | 109.48 | 6.90 | 3.00 | 103.11 | 116.81 |
| OUTDOOR | NO | NO | 40.95 | 7.79 | 2.00 | 35.44 | 46.45 |
| | | YES | 45.13 | 19.74 | 2.00 | 31.17 | 59.08 |
| | YES | NO | 31.75 | 4.89 | 3.00 | 26.57 | 36.29 |
| | | YES | 52.92 | 19.70 | 3.00 | 37.55 | 75.13 |

## TABLE H-3. (continued)

**HEATING SYSTEM=ELECTRIC**

| | | | PHENANTHRENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N[a] | MIN[a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 38.09 | 5.01 | 2.00 | 34.54 | 41.63 |
| LIVING ROOM | NO | NO | 42.36 | 12.14 | 2.00 | 33.77 | 50.94 |
| BEDROOM | NO | NO | 37.20 | 18.49 | 2.00 | 24.13 | 50.28 |
| OUTDOOR | NO | NO | 21.97 | 16.79 | 2.00 | 10.10 | 33.84 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE H-4. SUMMARY OF ANTHRACENE LEVELS ($ng/m^3$) FOR THE DIFFERENT COMBINATIONS OF THE EXPERIMENTAL FACTORS.

**HEATING SYSTEM=GAS**

| | | | ANTHRACENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N[a] | MIN[a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 37.65 | 49.46 | 2.00 | 2.67 | 72.63 |
| | | YES | 4.68 | 1.27 | 2.00 | 3.78 | 5.58 |
| | YES | NO | 3.19 | 1.34 | 3.00 | 2.14 | 4.70 |
| | | YES | 8.07 | 4.51 | 3.00 | 5.01 | 13.25 |
| LIVING ROOM | NO | NO | 4.89 | 2.89 | 3.00 | 2.62 | 8.19 |
| | | YES | 9.53 | 1.95 | 2.00 | 8.15 | 10.91 |
| | YES | NO | 4.48 | 2.32 | 4.00 | 2.50 | 7.08 |
| | | YES | 7.75 | 2.09 | 4.00 | 5.82 | 10.52 |
| BEDROOM | NO | NO | 2.56 | 0.36 | 2.00 | 2.31 | 2.82 |
| | | YES | 5.69 | 2.57 | 2.00 | 3.87 | 7.50 |
| | YES | NO | 2.68 | 0.40 | 3.00 | 2.27 | 3.06 |
| | | YES | 6.12 | 1.71 | 3.00 | 4.35 | 7.77 |
| OUTDOOR | NO | NO | 3.88 | 0.44 | 2.00 | 3.57 | 4.20 |
| | | YES | 3.25 | 1.47 | 2.00 | 2.21 | 4.29 |
| | YES | NO | 2.09 | 1.34 | 3.00 | 1.20 | 3.62 |
| | | YES | 3.93 | 2.23 | 3.00 | 2.10 | 6.41 |

## TABLE H-4. (Continued)

HEATING SYSTEM=ELECTRIC

| | | | ANTHRACENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 2.18 | 0.98 | 2.00 | 1.48 | 2.87 |
| LIVING ROOM | NO | NO | 2.10 | 0.89 | 2.00 | 1.48 | 2.73 |
| BEDROOM | NO | NO | 2.35 | 1.46 | 2.00 | 1.32 | 3.39 |
| OUTDOOR | NO | NO | 0.97 | 0.55 | 2.00 | 0.58 | 1.38 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE H-5. SUMMARY OF FLUORANTHENE LEVELS ($ng/m^3$) FOR THE DIFFERENT COMBINATIONS OF THE EXPERIMENTAL FACTORS.

HEATING SYSTEM=GAS

| | | | FLUORANTHENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N[a] | MIN[a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 15.16 | 3.05 | 2.00 | 13.00 | 17.32 |
| | | YES | 16.55 | 3.17 | 2.00 | 14.31 | 18.79 |
| | YES | NO | 17.28 | 4.92 | 3.00 | 12.98 | 22.64 |
| | | YES | 24.58 | 1.66 | 3.00 | 23.09 | 26.37 |
| LIVING ROOM | NO | NO | 20.41 | 3.20 | 3.00 | 16.73 | 22.54 |
| | | YES | 20.53 | 2.79 | 2.00 | 18.56 | 22.51 |
| | YES | NO | 21.53 | 3.09 | 4.00 | 18.36 | 25.17 |
| | | YES | 31.97 | 5.94 | 4.00 | 26.11 | 37.37 |
| BEDROOM | NO | NO | 10.46 | 2.26 | 2.00 | 8.87 | 12.06 |
| | | YES | 15.65 | 3.31 | 2.00 | 13.31 | 17.99 |
| | YES | NO | 16.72 | 2.66 | 3.00 | 13.65 | 16.31 |
| | | YES | 22.06 | 0.63 | 3.00 | 21.41 | 22.66 |
| OUTDOOR | NO | NO | 15.24 | 4.39 | 2.00 | 12.14 | 16.35 |
| | | YES | 26.90 | 17.80 | 2.00 | 14.32 | 39.49 |
| | YES | NO | 12.12 | 0.18 | 3.00 | 11.95 | 12.31 |
| | | YES | 17.12 | 3.49 | 3.00 | 13.74 | 20.71 |

## TABLE H-5. (Continued)

**HEATING SYSTEM=ELECTRIC**

| | | | FLUORANTHENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 9.50 | 0.38 | 2.00 | 9.23 | 9.77 |
| LIVING ROOM | NO | NO | 12.38 | 3.43 | 2.00 | 9.94 | 14.79 |
| BEDROOM | NO | NO | 9.25 | 5.85 | 2.00 | 5.11 | 13.39 |
| OUTDOOR | NO | NO | 7.69 | 4.17 | 2.00 | 4.75 | 10.64 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

## TABLE H-6. SUMMARY OF PYRENE LEVELS (ng/m$^3$) FOR THE DIFFERENT COMBINATIONS OF THE EXPERIMENTAL FACTORS.

HEATING SYSTEM=GAS

| | | | PYRENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N[a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 7.14 | 1.38 | 2.00 | 6.18 | 8.11 |
| | | YES | 6.68 | 1.74 | 2.00 | 5.46 | 7.91 |
| | YES | NO | 8.03 | 2.40 | 3.00 | 5.67 | 10.48 |
| | | YES | 11.48 | 1.55 | 3.00 | 10.43 | 13.25 |
| LIVING ROOM | NO | NO | 10.24 | 1.33 | 3.00 | 8.72 | 11.17 |
| | | YES | 10.02 | 2.92 | 2.00 | 7.96 | 12.08 |
| | YES | NO | 9.00 | 1.78 | 4.00 | 7.28 | 10.85 |
| | | YES | 14.72 | 2.73 | 4.00 | 11.72 | 18.10 |
| BEDROOM | NO | NO | 4.83 | 0.64 | 2.00 | 4.37 | 5.28 |
| | | YES | 6.92 | 0.12 | 2.00 | 6.83 | 7.01 |
| | YES | NO | 7.10 | 1.22 | 3.00 | 5.81 | 8.23 |
| | | YES | 10.25 | 0.55 | 3.00 | 9.79 | 10.88 |
| OUTDOOR | NO | NO | 10.43 | 3.80 | 2.00 | 7.75 | 13.11 |
| | | YES | 17.41 | 13.47 | 2.00 | 7.88 | 26.93 |
| | YES | NO | 6.29 | 0.55 | 3.00 | 5.84 | 6.90 |
| | | YES | 9.78 | 2.92 | 3.00 | 7.28 | 13.00 |

TABLE H-6. (Continued)

**HEATING SYSTEM=ELECTRIC**

| | | | PYRENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 4.97 | 0.25 | 2.00 | 4.79 | 5.15 |
| LIVING ROOM | NO | NO | 5.10 | 1.13 | 2.00 | 4.30 | 5.90 |
| BEDROOM | NO | NO | 4.10 | 2.01 | 2.00 | 2.67 | 5.52 |
| OUTDOOR | NO | NO | 3.71 | 1.66 | 2.00 | 2.54 | 4.89 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE H-7. SUMMARY OF CYCLOPENTIA(c,d)PYRENE LEVELS (ng/$m^3$) FOR THE DIFFERENT COMBINATIONS OF THE EXPERIMENTAL FACTORS.

HEATING SYSTEM=GAS

| | | | CYCLOPENTA(C,D)PYRENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 0.75 | 0.08 | 2.00 | 0.69 | 0.80 |
| | | YES | 1.02 | 0.96 | 2.00 | 0.34 | 1.70 |
| | YES | NO | 0.24 | 0.21 | 3.00 | 0.00 | 0.41 |
| | | YES | 0.93 | 0.68 | 3.00 | 0.52 | 1.72 |
| LIVING ROOM | NO | NO | 0.70 | 0.20 | 3.00 | 0.52 | 0.92 |
| | | YES | 1.95 | 0.61 | 2.00 | 1.52 | 2.38 |
| | YES | NO | 0.21 | 0.07 | 4.00 | 0.15 | 0.30 |
| | | YES | 0.58 | 0.38 | 4.00 | 0.35 | 1.11 |
| BEDROOM | NO | NO | 0.93 | 0.40 | 2.00 | 0.65 | 1.21 |
| | | YES | 0.97 | 0.67 | 2.00 | 0.49 | 1.45 |
| | YES | NO | 0.19 | 0.10 | 3.00 | 0.10 | 0.30 |
| | | YES | 0.19 | 0.16 | 3.00 | 0.00 | 0.29 |
| OUTDOOR | NO | NO | 2.29 | 2.04 | 2.00 | 0.85 | 3.74 |
| | | YES | 1.55 | 1.66 | 2.00 | 0.38 | 2.72 |
| | YES | NO | 0.28 | 0.26 | 3.00 | 0.10 | 0.58 |
| | | YES | 0.47 | 0.22 | 3.00 | 0.23 | 0.64 |

## TABLE H-7. (Continued)

**HEATING SYSTEM=ELECTRIC**

|  |  |  | CYCLOPENTA(C,D)PYRENE |  |  |  |  |
|---|---|---|---|---|---|---|---|
|  |  |  | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING |  |  |  |  |  |
| KITCHEN | NO | NO | 0.16 | 0.23 | 2.00 | 0.00 | 0.33 |
| LIVING ROOM | NO | NO | 0.11 | 0.15 | 2.00 | 0.00 | 0.22 |
| BEDROOM | NO | NO | 0.00 | 0.00 | 2.00 | 0.00 | 0.00 |
| OUTDOOR | NO | NO | 0.11 | 0.06 | 2.00 | 0.07 | 0.15 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE H-8. SUMMARY OF BENZ(a)ANTHRACENE LEVELS (ng/$m^3$) FOR THE DIFFERENT COMBINATIONS OF THE EXPERIMENTAL FACTORS.

HEATING SYSTEM=GAS

| | | | BENZ(A)ANTHRACENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N[a] | MIN[a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 0.93 | 0.33 | 2.00 | 0.69 | 1.16 |
| | | YES | 1.71 | 1.38 | 2.00 | 0.74 | 2.68 |
| | YES | NO | 0.74 | 0.29 | 3.00 | 0.44 | 1.03 |
| | | YES | 1.67 | 0.96 | 3.00 | 1.01 | 2.77 |
| LIVING ROOM | NO | NO | 0.80 | 0.15 | 3.00 | 0.67 | 0.96 |
| | | YES | 3.00 | 1.15 | 2.00 | 2.18 | 3.81 |
| | YES | NO | 0.52 | 0.18 | 4.00 | 0.30 | 0.69 |
| | | YES | 1.83 | 0.55 | 4.00 | 1.25 | 2.35 |
| BEDROOM | NO | NO | 0.66 | 0.15 | 2.00 | 0.55 | 0.76 |
| | | YES | 1.12 | 0.16 | 2.00 | 1.01 | 1.24 |
| | YES | NO | 0.43 | 0.05 | 3.00 | 0.38 | 0.46 |
| | | YES | 0.83 | 0.14 | 3.00 | 0.73 | 0.98 |
| OUTDOOR | NO | NO | 2.73 | 0.05 | 2.00 | 2.69 | 2.77 |
| | | YES | 5.56 | 5.86 | 2.00 | 1.41 | 9.71 |
| | YES | NO | 0.88 | 0.20 | 3.00 | 0.67 | 1.07 |
| | | YES | 1.35 | 0.40 | 3.00 | 1.11 | 1.82 |

TABLE H-8. (Continued)

**HEATING SYSTEM=ELECTRIC**

| | | | BENZ(A)ANTHRACENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 0.28 | 0.03 | 2.00 | 0.26 | 0.30 |
| LIVING ROOM | NO | NO | 0.56 | 0.35 | 2.00 | 0.31 | 0.81 |
| BEDROOM | NO | NO | 0.10 | 0.14 | 2.00 | 0.00 | 0.19 |
| OUTDOOR | NO | NO | 0.23 | 0.00 | 2.00 | 0.23 | 0.23 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE H-9. SUMMARY OF CHRYSENE LEVELS (ng/m$^3$) FOR THE DIFFERENT COMBINATIONS OF THE EXPERIMENTAL FACTORS.

HEATING SYSTEM=GAS

|  |  |  | CHRYSENE |  |  |  |  |
|---|---|---|---|---|---|---|---|
|  |  |  | MEAN | STD a | N a | MIN a | MAX a |
| LOCATION | WOOD BURNING | SMOKING |  |  |  |  |  |
| KITCHEN | NO | NO | 1.43 | 0.09 | 2.00 | 1.37 | 1.49 |
|  |  | YES | 4.40 | 4.17 | 2.00 | 1.45 | 7.35 |
|  | YES | NO | 1.26 | 0.16 | 3.00 | 1.09 | 1.42 |
|  |  | YES | 2.97 | 1.40 | 3.00 | 1.98 | 4.58 |
| LIVING ROOM | NO | NO | 1.61 | 0.27 | 3.00 | 1.42 | 1.92 |
|  |  | YES | 6.63 | 2.80 | 2.00 | 4.65 | 8.61 |
|  | YES | NO | 1.18 | 0.38 | 4.00 | 0.67 | 1.60 |
|  |  | YES | 3.93 | 1.35 | 4.00 | 2.48 | 5.25 |
| BEDROOM | NO | NO | 1.00 | 0.12 | 2.00 | 0.92 | 1.08 |
|  |  | YES | 2.01 | 0.03 | 2.00 | 2.00 | 2.03 |
|  | YES | NO | 0.96 | 0.05 | 3.00 | 0.92 | 1.02 |
|  |  | YES | 1.75 | 0.03 | 3.00 | 1.72 | 1.77 |
| OUTDOOR | NO | NO | 3.97 | 0.06 | 2.00 | 3.92 | 4.01 |
|  |  | YES | 8.92 | 8.71 | 2.00 | 2.76 | 15.08 |
|  | YES | NO | 2.00 | 0.13 | 3.00 | 1.88 | 2.14 |
|  |  | YES | 2.62 | 0.24 | 3.00 | 2.43 | 2.89 |

## TABLE H-9. (Continued)

**HEATING SYSTEM=ELECTRIC**

| | | | CHRYSENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 0.59 | 0.03 | 2.00 | 0.57 | 0.61 |
| LIVING ROOM | NO | NO | 0.81 | 0.18 | 2.00 | 0.68 | 0.94 |
| BEDROOM | NO | NO | 0.50 | 0.13 | 2.00 | 0.41 | 0.59 |
| OUTDOOR | NO | NO | 0.73 | 0.33 | 2.00 | 0.50 | 0.97 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE H-10. SUMMARY OF BENZOFLUORANTHENE LEVELS (ng/m$^3$) FOR THE DIFFERENT COMBINATIONS OF THE EXPERIMENTAL FACTORS.

HEATING SYSTEM=GAS

|  |  |  | BENZOFLUORANTHENES |  |  |  |  |
|---|---|---|---|---|---|---|---|
| LOCATION | WOOD BURNING | SMOKING | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| KITCHEN | NO | NO | 1.73 | 0.02 | 2.00 | 1.72 | 1.75 |
|  |  | YES | 3.62 | 2.79 | 2.00 | 1.64 | 5.60 |
|  | YES | NO | 1.42 | 0.35 | 3.00 | 1.04 | 1.74 |
|  |  | YES | 2.53 | 0.95 | 3.00 | 1.51 | 3.39 |
| LIVING ROOM | NO | NO | 1.88 | 0.26 | 3.00 | 1.62 | 2.13 |
|  |  | YES | 4.92 | 1.34 | 2.00 | 3.97 | 5.87 |
|  | YES | NO | 1.36 | 0.27 | 4.00 | 1.15 | 1.75 |
|  |  | YES | 4.78 | 2.50 | 4.00 | 2.52 | 7.81 |
| BEDROOM | NO | NO | 1.54 | 0.86 | 2.00 | 0.93 | 2.15 |
|  |  | YES | 3.25 | 1.19 | 2.00 | 2.41 | 4.10 |
|  | YES | NO | 1.04 | 0.08 | 3.00 | 0.94 | 1.09 |
|  |  | YES | 1.50 | 0.22 | 3.00 | 1.26 | 1.68 |
| OUTDOOR | NO | NO | 5.45 | 0.77 | 2.00 | 4.91 | 6.00 |
|  |  | YES | 10.67 | 9.99 | 2.00 | 3.60 | 17.74 |
|  | YES | NO | 2.42 | 0.44 | 3.00 | 2.09 | 2.93 |
|  |  | YES | 3.26 | 0.22 | 3.00 | 3.00 | 3.41 |

TABLE H-10. (Continued)

**HEATING SYSTEM=ELECTRIC**

| | | | BENZOFLUORANTHENES | | | | |
|---|---|---|---|---|---|---|---|
| LOCATION | WOOD BURNING | SMOKING | MEAN | STD [a] | N [a] | MIN [a] | MAX[a] |
| KITCHEN | NO | NO | 0.37 | 0.26 | 2.00 | 0.18 | 0.55 |
| LIVING ROOM | NO | NO | 0.60 | 0.01 | 2.00 | 0.59 | 0.61 |
| BEDROOM | NO | NO | 0.13 | 0.18 | 2.00 | 0.00 | 0.25 |
| OUTDOOR | NO | NO | 0.73 | 0.53 | 2.00 | 0.35 | 1.10 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE H-11. SUMMARY OF BENZO(e)PYRENE LEVELS (ng/m$^3$) FOR THE DIFFERENT COMBINATIONS OF THE EXPERIMENTAL FACTORS.

HEATING SYSTEM=GAS

|  |  |  | BENZO(E)PYRENE |  |  |  |  |
|---|---|---|---|---|---|---|---|
|  |  |  | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING |  |  |  |  |  |
| KITCHEN | NO | NO | 1.02 | 0.02 | 2.00 | 1.01 | 1.03 |
|  |  | YES | 1.66 | 0.58 | 2.00 | 1.25 | 2.06 |
|  | YES | NO | 0.89 | 0.09 | 3.00 | 0.81 | 0.99 |
|  |  | YES | 1.69 | 0.70 | 3.00 | 0.90 | 2.24 |
| LIVING ROOM | NO | NO | 1.02 | 0.05 | 3.00 | 0.98 | 1.07 |
|  |  | YES | 2.47 | 0.40 | 2.00 | 2.18 | 2.76 |
|  | YES | NO | 0.81 | 0.17 | 4.00 | 0.64 | 1.03 |
|  |  | YES | 2.39 | 1.12 | 4.00 | 1.31 | 3.57 |
| BEDROOM | NO | NO | 1.00 | 0.39 | 2.00 | 0.73 | 1.28 |
|  |  | YES | 1.75 | 0.49 | 2.00 | 1.41 | 2.10 |
|  | YES | NO | 0.80 | 0.27 | 3.00 | 0.54 | 1.08 |
|  |  | YES | 0.87 | 0.14 | 3.00 | 0.72 | 1.00 |
| OUTDOOR | NO | NO | 2.98 | 0.14 | 2.00 | 2.88 | 3.08 |
|  |  | YES | 5.66 | 4.75 | 2.00 | 2.30 | 9.01 |
|  | YES | NO | 1.21 | 0.15 | 3.00 | 1.09 | 1.38 |
|  |  | YES | 1.83 | 0.23 | 3.00 | 1.59 | 2.05 |

TABLE H-11. (Continued)

HEATING SYSTEM=ELECTRIC

| | | | BENZO(E)PYRENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 0.12 | 0.17 | 2.00 | 0.00 | 0.24 |
| LIVING ROOM | NO | NO | 0.33 | 0.03 | 2.00 | 0.31 | 0.35 |
| BEDROOM | NO | NO | 0.10 | 0.14 | 2.00 | 0.00 | 0.19 |
| OUTDOOR | NO | NO | 0.52 | 0.32 | 2.00 | 0.29 | 0.74 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE H-12. SUMMARY OF INDENO(1,2,3-c,d)PYRENE LEVELS (ng/m$^3$) FOR THE DIFFERENT COMBINATIONS OF THE EXPERIMENTAL FACTORS.

HEATING SYSTEM=GAS

| | | | INDENO(1,2,3-C,D)PYRENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 0.89 | 0.00 | 2.00 | 0.89 | 0.90 |
| | | YES | 1.87 | 0.72 | 2.00 | 1.36 | 2.37 |
| | YES | NO | 0.71 | 0.11 | 3.00 | 0.59 | 0.81 |
| | | YES | 1.64 | 0.83 | 3.00 | 1.13 | 2.60 |
| LIVING ROOM | NO | NO | 0.94 | 0.11 | 3.00 | 0.83 | 1.04 |
| | | YES | 2.64 | 0.51 | 2.00 | 2.28 | 3.00 |
| | YES | NO | 0.58 | 0.10 | 4.00 | 0.48 | 0.72 |
| | | YES | 1.94 | 0.84 | 4.00 | 1.21 | 2.75 |
| BEDROOM | NO | NO | 1.32 | 0.91 | 2.00 | 0.68 | 1.97 |
| | | YES | 2.55 | 1.38 | 2.00 | 1.58 | 3.53 |
| | YES | NO | 0.53 | 0.07 | 3.00 | 0.48 | 0.61 |
| | | YES | 0.88 | 0.10 | 3.00 | 0.81 | 0.99 |
| OUTDOOR | NO | NO | 2.58 | 0.16 | 2.00 | 2.47 | 2.69 |
| | | YES | 4.98 | 4.88 | 2.00 | 1.52 | 8.43 |
| | YES | NO | 0.97 | 0.11 | 3.00 | 0.89 | 1.09 |
| | | YES | 1.26 | 0.34 | 3.00 | 1.07 | 1.65 |

TABLE H-12. (Continued)

**HEATING SYSTEM=ELECTRIC**

| | | | INDENO(1,2,3-C,D)PYRENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 0.08 | 0.11 | 2.00 | 0.00 | 0.16 |
| LIVING ROOM | NO | NO | 0.39 | 0.14 | 2.00 | 0.30 | 0.49 |
| BEDROOM | NO | NO | 0.00 | 0.00 | 2.00 | 0.00 | 0.00 |
| OUTDOOR | NO | NO | 0.28 | 0.13 | 2.00 | 0.18 | 0.37 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observec concentration, and MAX is the highest observed concentration.

TABLE H-13. SUMMARY OF BENZO(g,h,i)PERYLENE LEVELS (ng/$m^3$) FOR THE DIFFERENT COMBINATIONS OF THE EXPERIMENTAL FACTORS.

HEATING SYSTEM=GAS

| | | | BENZO(G,H,I)PERYLENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 1.77 | 0.03 | 2.00 | 1.75 | 1.79 |
| | | YES | 2.29 | 0.44 | 2.00 | 1.98 | 2.60 |
| | YES | NO | 1.14 | 0.23 | 3.00 | 0.98 | 1.40 |
| | | YES | 2.42 | 0.94 | 3.00 | 1.35 | 3.15 |
| LIVING ROOM | NO | NO | 1.90 | 0.88 | 3.00 | 1.40 | 2.65 |
| | | YES | 2.24 | 0.25 | 2.00 | 2.06 | 2.41 |
| | YES | NO | 0.81 | 0.17 | 4.00 | 0.57 | 0.97 |
| | | YES | 2.24 | 0.66 | 4.00 | 1.50 | 2.83 |
| BEDROOM | NO | NO | 2.30 | 1.27 | 2.00 | 1.41 | 3.20 |
| | | YES | 3.67 | 2.45 | 2.00 | 1.94 | 5.40 |
| | YES | NO | 0.76 | 0.06 | 3.00 | 0.72 | 0.83 |
| | | YES | 1.01 | 0.05 | 3.00 | 0.95 | 1.06 |
| OUTDOOR | NO | NO | 4.93 | 0.25 | 2.00 | 4.75 | 5.10 |
| | | YES | 7.71 | 7.03 | 2.00 | 2.74 | 12.68 |
| | YES | NO | 1.55 | 0.19 | 3.00 | 1.34 | 1.69 |
| | | YES | 2.68 | 1.08 | 3.00 | 1.72 | 3.82 |

TABLE H-13. (Continued)

HEATING SYSTEM=ELECTRIC

| | | | BENZO(G,H,I)PERYLENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N [a] | MIN [a] | MAX[a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 0.25 | 0.35 | 2.00 | 0.00 | 0.49 |
| LIVING ROOM | NO | NO | 0.47 | 0.02 | 2.00 | 0.45 | 0.48 |
| BEDROOM | NO | NO | 0.14 | 0.19 | 2.00 | 0.00 | 0.27 |
| OUTDOOR | NO | NO | 0.46 | 0.24 | 2.00 | 0.29 | 0.64 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentrationl

## TABLE 14. SUMMARY OF CORONENE LEVELS (ng/m$^3$) FOR THE DIFFERENT COMBINATIONS OF THE EXPERIMENTAL FACTORS.

HEATING SYSTEM=GAS

| | | | CORONENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| KITCHEN | NO | NO | 1.61 | 0.09 | 2.00 | 1.55 | 1.67 |
| | | YES | 2.09 | 0.02 | 2.00 | 2.08 | 2.10 |
| | YES | NO | 0.75 | 0.21 | 3.00 | 0.58 | 0.99 |
| | | YES | 1.98 | 1.08 | 3.00 | 0.92 | 3.08 |
| LIVING ROOM | NO | NO | 1.62 | 0.78 | 3.00 | 1.00 | 2.50 |
| | | YES | 1.23 | 0.18 | 2.00 | 1.10 | 1.36 |
| | YES | NO | 0.43 | 0.16 | 4.00 | 0.30 | 0.67 |
| | | YES | 1.03 | 0.15 | 4.00 | 0.90 | 1.19 |
| BEDROOM | NO | NO | 2.11 | 1.26 | 2.00 | 1.22 | 3.00 |
| | | YES | 2.42 | 3.29 | 2.00 | 0.10 | 4.75 |
| | YES | NO | 0.48 | 0.12 | 3.00 | 0.36 | 0.59 |
| | | YES | 0.58 | 0.26 | 3.00 | 0.30 | 0.82 |
| OUTDOOR | NO | NO | 3.13 | 0.66 | 2.00 | 2.67 | 3.60 |
| | | YES | 4.33 | 3.95 | 2.00 | 1.54 | 7.13 |
| | YES | NO | 0.97 | 0.07 | 3.00 | 0.91 | 1.03 |
| | | YES | 1.50 | 0.80 | 3.00 | 0.85 | 2.39 |

## TABLE H-14. (Continued)

**HEATING SYSTEM=ELECTRIC**

|  |  |  | CORONENE |  |  |  |  |
|---|---|---|---|---|---|---|---|
|  |  |  | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING |  |  |  |  |  |
| KITCHEN | NO | NO | 0.11 | 0.15 | 2.00 | 0.00 | 0.22 |
| LIVING ROOM | NO | NO | 0.14 | 0.20 | 2.00 | 0.00 | 0.28 |
| BEDROOM | NO | NO | 0.12 | 0.18 | 2.00 | 0.00 | 0.23 |
| OUTDOOR | NO | NO | 0.31 | 0.13 | 2.00 | 0.22 | 0.40 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

TABLE H-15. SUMMARY OF 2-NITROFLUORANTHENE LEVELS (ng/m$^3$) FOR THE DIFFERENT COMBINATIONS OF THE EXPERIMENTAL FACTORS.

HEATING SYSTEM=GAS

| | | | 2-NITROFLUORANTHENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| INDOOR,C-OMB | NO | NO | 0.023 | 0.014 | 2 | 0.013 | 0.032 |
| | | YES | 0.138 | 0.006 | 2 | 0.134 | 0.143 |
| | YES | NO | 0.040 | 0.019 | 3 | 0.028 | 0.062 |
| | | YES | 0.071 | 0.016 | 3 | 0.055 | 0.087 |
| OUTDOOR | NO | NO | 0.067 | 0.021 | 2 | 0.052 | 0.082 |
| | | YES | 0.144 | 0.034 | 2 | 0.120 | 0.168 |
| | YES | NO | 0.107 | 0.071 | 3 | 0.049 | 0.185 |
| | | YES | 0.118 | 0.078 | 3 | 0.028 | 0.167 |

TABLE H-15. (Continued)

**HEATING SYSTEM=ELECTRIC**

| | | | 2-NITROFLUORANTHENE | | | | |
|---|---|---|---|---|---|---|---|
| | | | MEAN | STD [a] | N [a] | MIN [a] | MAX [a] |
| LOCATION | WOOD BURNING | SMOKING | | | | | |
| INDOOR,C-OMB | NO | NO | 0.037 | 0.042 | 2 | 0.008 | 0.067 |
| OUTDOOR | NO | NO | 0.005 | 0.001 | 2 | 0.005 | 0.006 |

[a] STD is the standard deviation, N is the number of samples, MIN is the lowest observed concentration, and MAX is the highest observed concentration.

# APPENDIX I

# COMPARISON OF INDOOR TO OUTDOOR CONCENTRATIONS OF THE TARGET COMPOUNDS

TABLE I-1. LEVELS OF TARGET COMPOUNDS FOUND IN INDOOR AND OUTDOOR AIR SAMPLES FROM HOMES A, B, C, AND C2.

| | Concentration, ng/m3[a] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Home A | | Home B | | Home C | | Home C2 | |
| Compound | Indoor | Outdoor | Indoor | Outdoor | Indoor | Outdoor | Indoor | Outdoor |
| Quinoline | 1.17 | 0.21 | 1.92 | 0.28 | 1.41 | 0.11 | 1.55 | 0.18 |
| Isoquinoline | 0.93 | 0.18 | 1.52 | 0.15 | 0.89 | 0.17 | 1.12 | 0.17 |
| Phenanthrene | 60.09 | 35.44 | 73.45 | 36.29 | 64.66 | 32.40 | 58.68 | 26.57 |
| Anthracene | 2.88 | 4.20 | 4.52 | 3.62 | 2.66 | 1.43 | 2.30 | 1.20 |
| Fluoranthene | 15.87 | 18.35 | 22.04 | 11.95 | 17.59 | 12.09 | 15.44 | 12.31 |
| Pyrene | 7.54 | 13.11 | 9.37 | 6.90 | 7.95 | 5.84 | 6.25 | 6.13 |
| Cyclopenta(c,d)pyrene | 0.62 | 3.74 | 0.23 | 0.17 | 0.27 | 0.10 | 0.11 | 0.58 |
| Benz(a)anthracene | 0.64 | 2.69 | 0.62 | 0.90 | 0.43 | 0.67 | 0.72 | 1.07 |
| Chrysene | 1.24 | 3.92 | 1.18 | 1.98 | 1.09 | 1.88 | 1.29 | 2.14 |
| Benzofluoranthenes | 1.50 | 4.91 | 1.30 | 2.25 | 1.15 | 2.09 | 1.43 | 2.93 |
| Benzo(e)pyrene | 0.91 | 2.88 | 0.85 | 1.16 | 0.78 | 1.09 | 0.93 | 1.38 |
| Benzo(a)pyrene | 0.93 | 2.85 | 0.73 | 0.73 | 0.55 | 0.63 | 0.71 | 1.24 |
| Indeno(1,2,3-c,d)pyrene | 0.80 | 2.47 | 0.59 | 0.89 | 0.65 | 0.93 | 0.60 | 1.09 |
| Benzo(g,h,i)perylene | 1.52 | 5.10 | 0.98 | 1.62 | 0.92 | 1.33 | 0.89 | 1.69 |
| Coronene | 1.30 | 3.60 | 0.55 | 1.03 | 0.51 | 0.96 | 0.62 | 0.91 |
| 1-Nitropyrene | 0.069 | 0.025 | 0.026 | 0.038 | 0.019 | 0.042 | 0.026 | 0.019 |
| 2-Nitrofluoranthene | 0.032 | 0.082 | 0.030 | 0.086 | 0.028 | 0.049 | 0.061 | 0.185 |

[a] Indoor levels are the sum of concentrations in the kitchen, living room, and bedroom.

## TABLE I-2. LEVELS OF TARGET COMPOUNDS FOUND IN INDOOR AND OUTDOOR AIR SAMPLES FROM HOMES D, E, F, AND F2.

| Compound | Concentration, ng/m3[a] | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Home D | | Home E | | Home F | | Home F2 | |
| | Indoor | Outdoor | Indoor | Outdoor | Indoor | Outdoor | Indoor | Outdoor |
| Quinoline | 8.03 | 0.88 | 19.62 | 0.83 | 14.47 | 0.45 | 9.40 | 0.27 |
| Isoquinoline | 3.83 | 1.14 | 42.46 | 0.67 | 10.40 | 1.54 | 4.19 | 1.75 |
| Phenanthrene | 128.32 | 75.13 | 69.06 | 31.17 | 115.97 | 46.09 | 110.43 | 37.55 |
| Anthracene | 10.51 | 6.41 | 6.48 | 2.21 | 5.83 | 3.28 | 6.00 | 2.10 |
| Fluoranthene | 24.63 | 20.71 | 16.95 | 14.32 | 27.92 | 16.90 | 24.45 | 13.74 |
| Pyrene | 12.55 | 13.00 | 6.81 | 7.88 | 12.97 | 9.07 | 10.65 | 7.28 |
| Cyclopenta(c,d)pyrene | 1.04 | 0.64 | 0.78 | 0.38 | 0.29 | 0.55 | 0.41 | 0.23 |
| Benz(a)anthracene | 1.74 | 1.82 | 1.31 | 1.41 | 1.33 | 1.11 | 1.08 | 1.12 |
| Chrysene | 3.14 | 2.89 | 2.71 | 2.76 | 3.00 | 2.53 | 2.20 | 2.43 |
| Benzofluoranthenes | 2.39 | 3.41 | 2.68 | 3.60 | 3.40 | 3.37 | 2.01 | 3.00 |
| Benzo(e)pyrene | 1.42 | 2.05 | 1.61 | 2.30 | 2.02 | 1.85 | 1.11 | 1.59 |
| Benzo(a)pyrene | 1.65 | 1.94 | 1.70 | 1.62 | 1.88 | 1.70 | 0.97 | 1.17 |
| Indeno(1,2,3-c,d)pyrene | 1.55 | 1.65 | 1.98 | 1.52 | 1.52 | 1.07 | 1.11 | 1.07 |
| Benzo(g,h,i)perylene | 2.03 | 3.82 | 2.11 | 2.74 | 2.15 | 2.49 | 1.29 | 1.72 |
| Coronene | 1.32 | 2.39 | 1.09 | 1.54 | 1.43 | 1.26 | 0.82 | 0.85 |
| 1-Nitropyrene | 0.056 | 0.020 | 0.052 | 0.013 | 0.014 | 0.027 | 0.005 | 0.017 |
| 2-Nitrofluoranthene | 0.087 | 0.028 | 0.143 | 0.120 | 0.071 | 0.167 | 0.055 | 0.161 |

[a] Indoor levels are the sum of concentrations in the kitchen, living room, and bedroom.

## TABLE I-3. LEVELS OF TARGET COMPOUNDS FOUND IN INDOOR AND OUTDOOR AIR SAMPLES FROM HOMES G, H, I, AND J.

| Compound | Concentration, ng/m3(a) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Home G | | Home H | | Home I | | Home J | |
| | Indoor | Outdoor | Indoor | Outdoor | Indoor | Outdoor | Indoor | Outdoor |
| Quinoline | 1.93 | 1.62 | 0.91 | 0.51 | 7.09 | 0.50 | 12.10 | 2.03 |
| Isoquinoline | 1.26 | 1.19 | 0.65 | 0.42 | 7.47 | 0.59 | 6.89 | 1.66 |
| Phenanthrene | 47.62 | 33.84 | 30.81 | 10.10 | 65.25 | 46.45 | 72.29 | 59.08 |
| Anthracene | 3.00 | 1.36 | 1.42 | 0.58 | 27.88 | 3.57 | 6.79 | 4.29 |
| Fluoranthene | 12.65 | 10.64 | 8.10 | 4.75 | 14.31 | 12.14 | 18.20 | 39.49 |
| Pyrene | 5.40 | 4.89 | 4.04 | 2.54 | 7.07 | 7.75 | 8.94 | 26.93 |
| Cyclopenta(c,d)pyrene | 0.18 | 0.15 | 0.00 | 0.07 | 0.98 | 0.85 | 1.84 | 2.72 |
| Benz(a)anthracene | 0.35 | 0.23 | 0.27 | 0.23 | 0.96 | 2.77 | 2.59 | 9.71 |
| Chrysene | 0.70 | 0.97 | 0.57 | 0.50 | 1.50 | 4.01 | 5.99 | 15.08 |
| Benzofluoranthenes | 0.26 | 1.10 | 0.47 | 0.35 | 1.83 | 6.00 | 5.19 | 17.74 |
| Benzo(e)pyrene | 0.10 | 0.74 | 0.26 | 0.29 | 1.12 | 3.08 | 2.31 | 9.01 |
| Benzo(a)pyrene | 0.00 | 0.00 | 0.18 | 0.20 | 1.09 | 3.17 | 3.40 | 2.02 |
| Indeno(1,2,3-c,d)pyrene | 0.16 | 0.37 | 0.15 | 0.18 | 1.28 | 2.69 | 2.73 | 8.43 |
| Benzo(g,h,i)perylene | 0.15 | 0.64 | 0.41 | 0.29 | 2.55 | 4.75 | 3.35 | 12.68 |
| Coronene | 0.00 | 0.40 | 0.24 | 0.22 | 2.35 | 2.67 | 2.74 | 7.13 |
| 1-Nitropyrene | 0.003 | 0.003 | 0.004 | 0.002 | 0.010 | 0.038 | INT(b) | 0.047 |
| 2-Nitrofluoranthene | 0.008 | 0.005 | 0.067(b) | 0.006 | 0.013 | 0.052 | 0.134(b) | 0.168 |

[a] Indoor levels are the sum of concentrations in the kitchen, living room, and bedroom.

[b] Interference peak eluting with the compound of interest.

# APPENDIX J

## SUMMARY OF THE STATISTICAL MODELING EFFORT FOR THE OTHER TARGET COMPOUNDS

## TABLE J-1. SUMMARY OF THE MODEL ESTIMATES FOR QUINOLINE

| Model Component | Coefficient Estimate | Standard Error of the Estimate | t-value (Statistical Significance)(a) |
|---|---|---|---|
| HS | 1.59 | 2.19 | 0.73 |
| WB | -1.78 | 1.26 | -1.42 |
| SM | 4.93 | 1.14 | 4.32 (.01) |
| (SM*WB) | -0.51 | 1.12 | -0.46 |
| L (Kitchen) | -1.20 | 1.32 | -0.90 |
| L (Living Room) | 3.01 | 1.26 | 2.39 (.05) |
| L (Bedroom) | -1.82 | 1.32 | -1.38 |
| H(b) | 0.00 | -- | -- |
| D(b) | 3.89 | 10.91 | -- |
| E(b) | 32.57 | 9.22 | -- |
| AER | -0.27 | 1.17 | -0.23 |

(a) The statistical significance given in parentheses is the probability that the given coefficient (or a larger value) could have occurred by chance if the corresponding experimental factor actually had no effect on concentration level. Thus, a small significance level (e.g. less than .10) indicates the factor likely has an effect on concentration level.

(.05) indicates statistical significance at the .05 level

(.01) indicates statistical significance at the .01 level

(b) The corresponding coefficient represents a variance estimate rather than a systematic fixed difference in concentration levels.

## TABLE J-2. COMPARISON OF ACTUAL AND PREDICTED CONCENTRATIONS OF QUINOLINE, in ng/m$^3$

| Gas-heated Homes | | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 1.47 | 3.03 | 9.70 | 13.92 |
| | | Living Room | 5.53 | 7.24 | 26.53 | 18.13 |
| | | Bedroom | 4.41 | 2.41 | 11.35 | 13.30 |
| | In Use | Kitchen | 1.05 | 0.48 | 10.99 | 9.34 |
| | | Living Room | 1.85 | 4.69 | 15.63 | 13.55 |
| | | Bedroom | 1.84 | -0.14 | 6.19 | 8.72 |

| Electrically Heated Homes | | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 2.86 | -0.15 | -- | -- |
| | | Living Room | 0.85 | 4.06 | -- | -- |
| | | Bedroom | 0.56 | -0.77 | -- | -- |

## TABLE J-3. SUMMARY OF THE MODEL ESTIMATES FOR ISOQUINOLINE

| Model Component | Coefficient Estimate | Standard Error of the Estimate | t-value (Statistical Significance)(a) |
|---|---|---|---|
| HS | 2.39 | 6.70 | 0.34 |
| WB | -6.74 | 3.69 | -1.83 (.01) |
| SM | 1.06 | 1.50 | 0.71 |
| (SM*WB) | -0.68 | 1.40 | -0.49 |
| L (Kitchen) | -0.19 | 1.42 | -0.13 |
| L (Living Room) | -1.17 | 1.35 | -0.87 |
| L (Bedroom) | 1.36 | 1.41 | 0.96 |
| H(b) | 0.00 | -- | -- |
| D(b) | 109.81 | 87.95 | -- |
| E(b) | 37.22 | 10.26 | -- |
| AER | 4.52 | 2.15 | 2.10 (.05) |

(a) The statistical significance given in parentheses is the probability that the given coefficient (or a larger value) could have occurred by chance if the corresponding experimental factor actually had no effect on concentration level. Thus, a small significance level (e.g. less than .10) indicates the factor likely has an effect on concentration level.

(.05) indicates statistical significance at the .05 level

(.01) indicates statistical significance at the .01 level

(b) The corresponding coefficient represents a variance estimate rather than a systematic fixed difference in concentration levels.

# TABLE J-4. COMPARISON OF ACTUAL AND PREDICTED CONCENTRATIONS OF ISOQUINOLINE, in ng/$m^3$

| | Gas-heated Homes | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 8.19 | 11.82 | 22.88 | 15.31 |
| | | Living Room | 2.79 | 10.84 | 16.87 | 14.33 |
| | | Bedroom | 0.67 | 13.38 | 34.29 | 16.87 |
| | In Use | Kitchen | 0.90 | -0.29 | 4.55 | 0.47 |
| | | Living Room | 1.23 | -1.27 | 7.51 | -0.51 |
| | | Bedroom | 1.31 | 1.27 | 7.18 | 2.03 |

| | Electrically Heated Homes | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 0.62 | 7.04 | -- | -- |
| | | Living Room | 0.73 | 6.06 | -- | -- |
| | | Bedroom | 1.52 | 8.61 | -- | -- |

## TABLE J-5. SUMMARY OF THE MODEL ESTIMATES FOR PHENANTHRENE

| Model Component | Coefficient Estimate | Standard Error of the Estimate | t-value (Statistical Significance)[a] |
|---|---|---|---|
| HS | 11.44 | 5.20 | 2.20 (.05) |
| WB | 13.65 | 3.32 | 4.11 (.01) |
| SM | 14.89 | 3.37 | 4.41 (.01) |
| (SM*WB) | 10.88 | 3.34 | 3.26 (.01) |
| L (Kitchen) | 0.13 | 2.29 | 0.05 |
| L (Living Room) | 6.08 | 2.19 | 2.78 (.01) |
| L (Bedroom) | -6.21 | 2.29 | -2.71 (.01) |
| H[b] | 61.61 | 63.56 | -- |
| D[b] | 0.83 | 24.71 | -- |
| E[b] | 97.17 | 26.89 | -- |
| AER | 0.25 | 2.82 | 0.08 |

(a) The statistical significance given in parentheses is the probability that the given coefficient (or a larger value) could have occurred by chance if the corresponding experimental factor actually had no effect on concentration level. Thus, a small significance level (e.g. less than .10) indicates the factor likely has an effect on concentration level.

(.05) indicates statistical significance at the .05 level

(.01) indicates statistical significance at the .01 level

(b) The corresponding coefficient represents a variance estimate rather than a systematic fixed difference in concentration levels.

TABLE J-6. COMPARISON OF ACTUAL AND PREDICTED CONCENTRATIONS OF PHENANTHRENE, in ng/m$^3$

| | Gas-heated Homes | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 68.67 | 62.56 | 65.14 | 70.59 |
| | | Living Room | 67.15 | 68.51 | 78.01 | 76.54 |
| | | Bedroom | 50.80 | 56.23 | 68.88 | 64.26 |
| | In Use | Kitchen | 63.60 | 68.11 | 121.32 | 119.65 |
| | | Living Room | 76.36 | 74.06 | 121.80 | 125.60 |
| | | Bedroom | 60.14 | 61.78 | 109.48 | 113.32 |

| | Electrically Heated Homes | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 38.09 | 39.69 | -- | -- |
| | | Living Room | 42.36 | 45.64 | -- | -- |
| | | Bedroom | 37.20 | 33.36 | -- | -- |

## TABLE J-7. SUMMARY OF THE MODEL ESTIMATES FOR ANTHRACENE

| Model Component | Coefficient Estimate | Standard Error of the Estimate | t-value[a] |
|---|---|---|---|
| HS | 6.15 | 4.71 | 1.31 |
| WB | -2.38 | 2.96 | -0.81 |
| SM | -1.01 | 3.01 | -0.34 |
| (SM*WB) | 3.09 | 3.00 | 1.03 |
| L (Kitchen) | 3.54 | 2.40 | 1.47 |
| L (Living Room) | -0.82 | 2.29 | -0.36 |
| L (Bedroom) | -2.72 | 2.40 | -1.13 |
| H[b] | 41.88 | 48.86 | -- |
| D[b] | 0.00 | -- | -- |
| E[b] | 107.17 | 29.33 | -- |
| AER | 0.16 | 2.67 | 0.06 |

(a) None of the components was statistically significant at the 0.10 level.

(b) The corresponding coefficient represents a variance estimate rather than a systematic fixed difference in concentration levels.

## TABLE J-8. COMPARISON OF ACTUAL AND PREDICTED CONCENTRATIONS OF ANTHRACENE, in ng/m$^3$

|  | Gas-heated Homes |  | Smoking |  |  |  |
|---|---|---|---|---|---|---|
|  |  |  | Absent |  | Present |  |
|  |  | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 37.65 | 18.26 | 4.68 | 10.06 |
|  |  | Living Room | 4.89 | 13.91 | 9.53 | 5.70 |
|  |  | Bedroom | 2.56 | 12.00 | 5.69 | 3.79 |
|  | In Use | Kitchen | 3.19 | 7.31 | 8.07 | 11.46 |
|  |  | Living Room | 4.48 | 2.96 | 7.75 | 7.11 |
|  |  | Bedroom | 2.68 | 1.05 | 6.12 | 5.20 |

|  | Electrically Heated Homes |  | Smoking |  |  |  |
|---|---|---|---|---|---|---|
|  |  |  | Absent |  | Present |  |
|  |  | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 2.18 | 5.97 | -- | -- |
|  |  | Living Room | 2.10 | 1.62 | -- | -- |
|  |  | Bedroom | 2.35 | -0.29 | -- | -- |

TABLE J-9. SUMMARY OF THE MODEL ESTIMATES FOR FLUORANTHENE

| Model Component | Coefficient Estimate | Standard Error of the Estimate | t-value (Statistical Significance)(a) |
|---|---|---|---|
| HS | 3.55 | 1.42 | 2.50 (.05) |
| WB | 2.93 | 0.87 | 3.38 (.01) |
| SM | 2.66 | 0.85 | 3.15 (.01) |
| (SM*WB) | 1.06 | 0.82 | 1.29 |
| L (Kitchen) | -0.99 | 0.67 | -1.47 |
| L (Living Room) | 3.72 | 0.64 | 5.81 (.01) |
| L (Bedroom) | -2.73 | 0.67 | 4.07 (.01) |
| H(b) | 2.81 | 4.08 | -- |
| D(b) | 0.92 | 2.54 | -- |
| E(b) | 8.35 | 2.32 | -- |
| AER | -1.45 | 0.78 | -1.87 (.10) |

(a) The statistical significance given in parentheses is the probability that the given coefficient (or a larger value) could have occurred by chance if the corresponding experimental factor actually had no effect on concentration level. Thus, a small significance level (e.g. less than .10) indicates the factor likely has an effect on concentration level.

(.10) indicates statistical significance at the .10 level

(.05) indicates statistical significance at the .05 level

(.01) indicates statistical significance at the .01 level

(b) The corresponding coefficient represents a variance estimate rather than a systematic fixed difference in concentration levels.

TABLE J-10. COMPARISON OF ACTUAL AND PREDICTED CONCENTRATIONS OF FLUORANTHENE, in ng/$m^3$

| | Gas-heated Homes | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 15.16 | 14.47 | 16.55 | 17.67 |
| | | Living Room | 20.41 | 19.17 | 20.53 | 22.37 |
| | | Bedroom | 10.46 | 12.72 | 15.65 | 15.92 |
| | In Use | Kitchen | 17.28 | 18.20 | 24.58 | 25.65 |
| | | Living Room | 21.53 | 22.90 | 31.97 | 30.35 |
| | | Bedroom | 16.72 | 16.45 | 22.06 | 23.90 |
| | Electrically Heated Homes | | Smoking | | | |
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 9.50 | 7.37 | -- | -- |
| | | Living Room | 12.36 | 12.07 | -- | -- |
| | | Bedroom | 9.25 | 5.63 | -- | -- |

## TABLE J-11. SUMMARY OF THE MODEL ESTIMATES FOR PYRENE

| Model Component | Coefficient Estimate | Standard Error of the Estimate | t-value (Statistical Significance)[(a)] |
|---|---|---|---|
| HS | 1.76 | 0.79 | 2.24 (.05) |
| WB | 1.23 | 0.46 | 2.70 (.01) |
| SM | 1.35 | 0.39 | 3.47 (.01) |
| (SM*WB) | 0.84 | 0.37 | 2.27 (.05) |
| L (Kitchen) | -0.35 | 0.35 | -1.00 |
| L (Living Room) | 1.72 | 0.33 | 5.20 (.01) |
| L (Bedroom) | -1.37 | 0.35 | -3.91 (.01) |
| H(b) | 0.31 | 0.98 | -- |
| D(b) | 0.72 | 1.08 | -- |
| E(b) | 2.23 | 0.62 | -- |
| AER | -0.61 | 0.39 | -1.58 |

(a) The statistical significance given in parentheses is the probability that the given coefficient (or a larger value) could have occurred by chance if the corresponding experimental factor actually had no effect on concentration level. Thus, a small significance level (e.g. less than .10) indicates the factor likely has an effect on concentration level.

(.05) indicates statistical significance at the .05 level

(.01) indicates statistical significance at the .01 level

(b) The corresponding coefficient represents a variance estimate rather than a systematic fixed difference in concentration levels.

## TABLE J-12. COMPARISON OF ACTUAL AND PREDICTED CONCENTRATIONS OF PYRENE, in ng/m$^3$

| Gas-heated Homes | | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 7.14 | 7.06 | 6.68 | 8.08 |
| | | Living Room | 10.24 | 9.13 | 10.02 | 10.15 |
| | | Bedroom | 4.83 | 6.03 | 6.92 | 7.05 |
| | In Use | Kitchen | 8.03 | 7.85 | 11.48 | 12.23 |
| | | Living Room | 9.01 | 9.92 | 14.72 | 14.29 |
| | | Bedroom | 7.10 | 6.82 | 10.25 | 11.19 |

| Electrically Heated Homes | | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 4.97 | 3.53 | -- | -- |
| | | Living Room | 5.10 | 5.60 | -- | -- |
| | | Bedroom | 4.10 | 2.50 | -- | -- |

## TABLE J-13. SUMMARY OF THE MODEL ESTIMATES FOR CYCLOPENTA(C,D)PYRENE

| Model Component | Coefficient Estimate | Standard Error of the Estimate | t-value (Statistical Significance)[a] |
|---|---|---|---|
| HS | 0.32 | 0.23 | 1.39 |
| WB | -0.28 | 0.14 | -2.09 (.05) |
| SM | 0.30 | 0.11 | 2.62 (.01) |
| (SM*WB) | -0.04 | 0.11 | -0.35 |
| L (Kitchen) | 0.05 | 0.07 | 0.75 |
| L (Living Room) | 0.10 | 0.07 | 1.46 |
| L (Bedroom) | -0.15 | 0.07 | -2.14 (.05) |
| H[b] | 0.05 | 0.11 | -- |
| D[b] | 0.07 | 0.11 | -- |
| E[b] | 0.09 | 0.03 | -- |
| AER | -0.03 | 0.11 | -0.32 |

(a) The statistical significance given in parentheses is the probability that the given coefficient (or a larger value) could have occurred by chance if the corresponding experimental factor actually had no effect on concentration level. Thus, a small significance level (e.g. less than .10) indicates the factor likely has an effect on concentration level.

(.05) indicates statistical significance at the .05 level

(.01) indicates statistical significance at the .01 level

(b) The corresponding coefficient represents a variance estimate rather than a systematic fixed difference in concentration levels.

## TABLE J-14. COMPARISON OF ACTUAL AND PREDICTED CONCENTRATIONS OF CYCLOPENTA(C,D)PYRENE, in ng/m$^3$

| Gas-heated Homes | | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 0.75 | 0.74 | 1.02 | 1.41 |
| | | Living Room | 0.70 | 0.79 | 1.95 | 1.45 |
| | | Bedroom | 0.93 | 0.54 | 0.97 | 1.20 |
| | In Use | Kitchen | 0.24 | 0.25 | 0.94 | 0.77 |
| | | Living Room | 0.21 | 0.29 | 0.58 | 0.81 |
| | | Bedroom | 0.19 | 0.04 | 0.19 | 0.56 |

| Electrically Heated Homes | | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 0.16 | 0.10 | -- | -- |
| | | Living Room | 0.11 | 0.14 | -- | -- |
| | | Bedroom | 0.00 | -0.11 | -- | -- |

## TABLE J-15. SUMMARY OF THE MODEL ESTIMATES FOR BENZ(A)ANTHRACENE

| Model Component | Coefficient Estimate | Standard Error of the Estimate | t-value (Statistical Significance)(a) |
|---|---|---|---|
| HS | 0.35 | 0.24 | 1.45 |
| WB | -0.17 | 0.15 | -1.12 |
| SM | 0.58 | 0.15 | 3.73 (.01) |
| (SM*WB) | -0.08 | 0.15 | -0.50 |
| L (Kitchen) | 0.09 | 0.11 | 0.78 |
| L (Living Room) | 0.28 | 0.11 | 2.60 (.01) |
| L (Bedroom) | -0.37 | 0.11 | -3.36 (.01) |
| H(b) | 0.12 | 0.13 | -- |
| D(b) | 0.00 | -- | -- |
| E(b) | 0.24 | 0.07 | -- |
| AER | -0.17 | 0.13 | -1.30 |

(a) The statistical significance given in parentheses is the probability that the given coefficient (or a larger value) could have occurred by chance if the corresponding experimental factor actually had no effect on concentration level. Thus, a small significance level (e.g. less than .10) indicates the factor likely has an effect on concentration level.

(.01) indicates statistical significance at the .01 level

(b) The corresponding coefficient represents a variance estimate rather than a systematic fixed difference in concentration levels.

## TABLE J-16. COMPARISON OF ACTUAL AND PREDICTED CONCENTRATIONS OF BENZ(A)ANTHRACENE, in ng/m$^3$

| Gas-heated Homes | | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 0.93 | 0.85 | 1.71 | 2.16 |
| | | Living Room | 0.80 | 1.05 | 3.00 | 2.35 |
| | | Bedroom | 0.66 | 0.39 | 1.12 | 1.70 |
| | In Use | Kitchen | 0.74 | 0.67 | 1.67 | 1.67 |
| | | Living Room | 0.52 | 0.86 | 1.83 | 1.86 |
| | | Bedroom | 0.43 | 0.21 | 0.83 | 1.21 |

| Electrically Heated Homes | | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 0.28 | 0.16 | -- | -- |
| | | Living Room | 0.56 | 0.35 | -- | -- |
| | | Bedroom | 0.10 | -0.30 | -- | -- |

## TABLE J-17. SUMMARY OF THE MODEL ESTIMATES FOR CHRYSENE

| Model Component | Coefficient Estimate | Standard Error of the Estimate | t-value (Statistical Significance)(a) |
|---|---|---|---|
| HS | 0.69 | 0.51 | 1.35 |
| WB | -0.41 | 0.32 | -1.28 |
| SM | 1.35 | 0.33 | 4.12 (.01) |
| (SM*WB) | -0.38 | 0.33 | -1.15 |
| L (Kitchen) | 0.09 | 0.26 | 0.36 |
| L (Living Room) | 0.68 | 0.24 | 2.77 (.01) |
| L (Bedroom) | -0.77 | 0.26 | -2.96 (.01) |
| H(b) | 0.51 | 0.58 | -- |
| D(b) | 0.00 | -- | -- |
| E(b) | 1.22 | 0.33 | -- |
| AER | -0.53 | 0.29 | -1.83 |

(a) The statistical significance given in parentheses is the probability that the given coefficient (or a larger value) could have occurred by chance if the corresponding experimental factor actually had no effect on concentration level. Thus, a small significance level (e.g. less than .10) indicates the factor likely has an effect on concentration level.

(.01) indicates statistical significance at the .01 level

(b) The corresponding coefficient represents a variance estimate rather than a systematic fixed difference in concentration levels.

TABLE J-18. COMPARISON OF ACTUAL AND PREDICTED CONCENTRATIONS OF CHRYSENE, in ng/$m^3$

| Gas-heated Homes | | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 1.43 | 1.38 | 4.40 | 4.83 |
| | | Living Room | 1.61 | 1.96 | 6.63 | 5.42 |
| | | Bedroom | 1.00 | 0.52 | 2.01 | 3.97 |
| | In Use | Kitchen | 1.26 | 1.31 | 2.97 | 3.26 |
| | | Living Room | 1.18 | 1.89 | 3.93 | 3.84 |
| | | Bedroom | 0.96 | 0.45 | 1.75 | 2.40 |

| Electrically Heated Homes | | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 0.59 | -0.01 | -- | -- |
| | | Living Room | 0.81 | 0.58 | -- | -- |
| | | Bedroom | 0.50 | -0.87 | -- | -- |

## TABLE J-19. SUMMARY OF THE MODEL ESTIMATES FOR BENZOFLUORANTHENES

| Model Component | Coefficient Estimate | Standard Error of the Estimate | t-value (Statistical Significance)(a) |
|---|---|---|---|
| HS | 1.14 | 0.31 | 3.65 (.01) |
| WB | -0.38 | 0.19 | -2.05 (.05) |
| SM | 1.13 | 0.19 | 6.04 (.01) |
| (SM*WB) | -0.30 | 0.19 | -1.58 |
| L (Kitchen) | -0.08 | 0.23 | -0.36 |
| L (Living Room) | 0.65 | 0.21 | 3.02 (.01) |
| L (Bedroom) | -0.57 | 0.23 | -2.48 (.01) |
| H(b) | 0.03 | 0.23 | -- |
| D(b) | 0.00 | -- | -- |
| E(b) | 0.94 | 0.26 | -- |
| AER | -0.74 | 0.19 | -3.91 (.01) |

(a) The statistical significance given in parentheses is the probability that the given coefficient (or a larger value) could have occurred by chance if the corresponding experimental factor actually had no effect on concentration level. Thus, a small significance level (e.g. less than .10) indicates the factor likely has an effect on concentration level.

(.05) indicates statistical significance at the .05 level

(.01) indicates statistical significance at the .01 level

(b) The corresponding coefficient represents a variance estimate rather than a systematic fixed difference in concentration levels.

TABLE J-20. COMPARISON OF ACTUAL AND PREDICTED CONCENTRATIONS OF BENZOFLUORANTHENES, in ng/$m^3$

| Gas-heated Homes | | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 1.73 | 1.54 | 3.62 | 4.40 |
| | | Living Room | 1.86 | 2.27 | 4.92 | 5.13 |
| | | Bedroom | 1.54 | 1.06 | 3.25 | 3.91 |
| | In Use | Kitchen | 1.42 | 1.38 | 2.53 | 3.03 |
| | | Living Room | 1.36 | 2.12 | 4.78 | 3.76 |
| | | Bedroom | 1.04 | 0.90 | 1.50 | 2.55 |

| Electrically Heated Homes | | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 0.37 | -0.74 | -- | -- |
| | | Living Room | 0.60 | -0.01 | -- | -- |
| | | Bedroom | 0.13 | -1.23 | -- | -- |

## TABLE J-21. SUMMARY OF THE MODEL ESTIMATES FOR BENZO(E)PYRENE

| Model Component | Coefficient Estimate | Standard Error of the Estimate | t-value (Statistical Significance)[a] |
|---|---|---|---|
| HS | 0.59 | 0.14 | 4.19 (.01) |
| WB | -0.13 | 0.08 | -1.58 |
| SM | 0.50 | 0.08 | 6.04 (.01) |
| (SM*WB) | -0.10 | 0.09 | -1.16 |
| L (Kitchen) | -0.02 | 0.11 | 0.20 |
| L (Living Room) | 0.26 | 0.10 | 2.56 (.05) |
| L (Bedroom) | -0.24 | 0.11 | -2.18 (.01) |
| H[b] | 0.00 | -- | -- |
| D[b] | 0.00 | -- | -- |
| E[b] | 0.21 | 0.05 | -- |
| AER | -0.28 | 0.01 | -3.32 (.01) |

(a) The statistical significance given in parentheses is the probability that the given coefficient (or a larger value) could have occurred by chance if the corresponding experimental factor actually had no effect on concentration level. Thus, a small significance level (e.g. less than .10) indicates the factor likely has an effect on concentration level.

(.05) indicates statistical significance at the .05 level

(.01) indicates statistical significance at the .01 level

(b) The corresponding coefficient represents a variance estimate rather than a systematic fixed difference in concentration levels.

## TABLE J-22. COMPARISON OF ACTUAL AND PREDICTED CONCENTRATIONS OF BENZO(E)PYRENE, in ng/$m^3$

| | Gas-heated Homes | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 1.02 | 0.95 | 1.66 | 2.15 |
| | | Living Room | 1.02 | 1.23 | 2.47 | 2.43 |
| | | Bedroom | 1.00 | 0.73 | 1.75 | 1.93 |
| | In Use | Kitchen | 0.89 | 0.89 | 1.69 | 1.69 |
| | | Living Room | 0.81 | 1.17 | 2.39 | 1.97 |
| | | Bedroom | 0.80 | 0.67 | 0.87 | 1.47 |

| | Electrically Heated Homes | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 0.12 | -0.23 | -- | -- |
| | | Living Room | 0.33 | 0.05 | -- | -- |
| | | Bedroom | 0.10 | -0.45 | -- | -- |

## TABLE J-23. SUMMARY OF THE MODEL ESTIMATES FOR INDENO(1,2,3-C,D)PYRENE

| Model Component | Coefficient Estimate | Standard Error of the Estimate | t-value (Statistical Significance)[a] |
|---|---|---|---|
| HS | 0.53 | 0.16 | 3.21 (.01) |
| WB | -0.33 | 0.10 | -3.39 (.01) |
| SM | 0.58 | 0.10 | 6.01 (.01) |
| (SM*WB) | -0.14 | 0.10 | -1.43 |
| L (Kitchen) | -0.05 | 0.13 | -0.37 |
| L (Living Room) | 0.15 | 0.12 | 1.30 |
| L (Bedroom) | -0.10 | 0.13 | -0.77 |
| H[b] | 0.00 | -- | -- |
| D[b] | 0.00046 | 0.043 | -- |
| E[b] | 0.29 | 0.08 | -- |
| AER | -0.15 | 0.10 | -1.52 (.01) |

(a) The statistical significance given in parentheses is the probability that the given coefficient (or a larger value) could have occurred by chance if the corresponding experimental factor actually had no effect on concentration level. Thus, a small significance level (e.g. less than .10) indicates the factor likely has an effect on concentration level.

(.01) indicates statistical significance at the .01 level

(b) The corresponding coefficient represents a variance estimate rather than a systematic fixed difference in concentration levels.

## TABLE J-24. COMPARISON OF ACTUAL AND PREDICTED CONCENTRATIONS OF INDENO(1,2,3-C,D)PYRENE, in ng/m$^3$

| | Gas-heated Homes | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 0.89 | 0.96 | 1.87 | 2.42 |
| | | Living Room | 0.94 | 1.17 | 2.64 | 2.62 |
| | | Bedroom | 1.32 | 0.90 | 2.55 | 2.36 |
| | In Use | Kitchen | 0.71 | 0.59 | 1.64 | 1.47 |
| | | Living Room | 0.58 | 0.80 | 1.94 | 1.68 |
| | | Bedroom | 0.53 | 0.53 | 0.88 | 1.41 |

| | Electrically Heated Homes | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 0.08 | -0.10 | -- | -- |
| | | Living Room | 0.39 | 0.10 | -- | -- |
| | | Bedroom | 0.00 | -0.16 | -- | -- |

## TABLE J-25. SUMMARY OF THE MODEL ESTIMATES FOR BENZO(G,H,I)PERYLENE

| Model Component | Coefficient Estimate | Standard Error of the Estimate | t-value (Statistical Significance)(a) |
|---|---|---|---|
| HS | 1.07 | 0.29 | 3.74 (.01) |
| WB | -0.48 | 0.18 | -2.74 (.01) |
| SM | 0.50 | 0.18 | 2.79 (.01) |
| (SM*WB) | 0.02 | 0.18 | 0.12 |
| L (Kitchen) | 0.07 | 0.16 | 0.45 |
| L (Living Room) | -0.01 | 0.16 | -0.01 |
| L (Bedroom) | -0.07 | 0.16 | 0.44 |
| H(b) | 0.12 | 0.19 | -- |
| D(b) | 0.00 | 0.00 | -- |
| E(b) | 0.50 | 0.14 | -- |
| AER | -0.31 | 0.17 | -1.82 (.01) |

(a) The statistical significance given in parentheses is the probability that the given coefficient (or a larger value) could have occurred by chance if the corresponding experimental factor actually had no effect on concentration level. Thus, a small significance level (e.g. less than .10) indicates the factor likely has an effect on concentration level.

(.01) indicates statistical significance at the .01 level

(b) The corresponding coefficient represents a variance estimate rather than a systematic fixed difference in concentration levels.

TABLE J-26. COMPARISON OF ACTUAL AND PREDICTED CONCENTRATIONS OF BENZO(G,H,I)PERYLENE in ng/m$^3$

| | Gas-heated Homes | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 1.77 | 2.08 | 2.29 | 3.03 |
| | | Living Room | 1.90 | 2.00 | 2.24 | 2.96 |
| | | Bedroom | 2.30 | 1.93 | 3.67 | 2.89 |
| | In Use | Kitchen | 1.14 | 1.07 | 2.42 | 2.11 |
| | | Living Room | 0.81 | 0.99 | 2.24 | 2.03 |
| | | Bedroom | 0.76 | 0.92 | 1.01 | 1.96 |

| | Electrically Heated Homes | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 0.25 | -0.07 | -- | -- |
| | | Living Room | 0.47 | 0.14 | -- | -- |
| | | Bedroom | 0.14 | -0.21 | -- | -- |

## TABLE J-27. SUMMARY OF THE MODEL ESTIMATES FOR CORONENE

| Model Component | Coefficient Estimate | Standard Error of the Estimate | t-value (Statistical Significance)[a] |
|---|---|---|---|
| HS | 0.97 | 0.31 | 3.12 (.01) |
| WB | -0.46 | 0.18 | -2.58 (.01) |
| SM | 0.23 | 0.15 | 1.52 |
| (SM*WB) | 0.08 | 0.15 | 0.56 |
| L (Kitchen) | 0.24 | 0.17 | 1.42 |
| L (Living Room) | -0.21 | 0.17 | -1.26 |
| L (Bedroom) | -0.03 | 0.17 | -0.18 |
| H[b] | 0.00 | -- | -- |
| D[b] | 0.11 | 0.15 | -- |
| E[b] | 0.54 | 0.14 | -- |
| AER | -0.24 | 0.16 | -1.55 |

(a) The statistical significance given in parentheses is the probability that the given coefficient (or a larger value) could have occurred by chance if the corresponding experimental factor actually had no effect on concentration level. Thus, a small significance level (e.g. less than .10) indicates the factor likely has an effect on concentration level.

(.01) indicates statistical significance at the .01 level

(b) The corresponding coefficient represents a variance estimate rather than a systematic fixed difference in concentration levels.

## TABLE J-28. COMPARISON OF ACTUAL AND PREDICTED CONCENTRATIONS OF CORONENE in ng/m$^3$

| | Gas-heated Homes | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 1.61 | 1.97 | 2.09 | 2.27 |
| | | Living Room | 1.62 | 1.53 | 1.23 | 1.83 |
| | | Bedroom | 2.11 | 1.69 | 2.42 | 2.00 |
| | In Use | Kitchen | 0.75 | 0.89 | 1.98 | 1.52 |
| | | Living Room | 0.43 | 0.44 | 1.03 | 1.07 |
| | | Bedroom | 0.48 | 0.61 | 0.58 | 1.24 |

| | Electrically Heated Homes | | Smoking | | | |
|---|---|---|---|---|---|---|
| | | | Absent | | Present | |
| | | Location | Actual | Predicted | Actual | Predicted |
| Woodburning Fireplace | Not in Use | Kitchen | 0.11 | 0.02 | -- | -- |
| | | Living Room | 0.14 | -0.42 | -- | -- |
| | | Bedroom | 0.12 | -0.25 | -- | -- |

## TABLE J-29. SUMMARY OF THE MODEL ESTIMATES FOR 2-NITROFLUORANTHENE

| Model Component | Coefficient Estimate | Standard Error of the Estimate | t-value (Statistical Significance)[a] |
|---|---|---|---|
| HS | -0.010 | 0.0131 | -0.77 |
| WB | -0.0105 | 0.0082 | -1.28 |
| SM | 0.0347 | 0.0084 | 4.14 (.01) |
| (SM*WB) | -0.0214 | 0.0083 | -2.57 (.01) |
| H[b] | 0.00018 | 0.00165 | -- |
| D[b] | 0.00000 | -- | -- |
| E[b] | 0.000386 | 0.00152 | -- |
| AER | 0.0041 | 0.0079 | 0.51 |

(a) The statistical significance given in parentheses is the probability that the given coefficient (or a larger value) could have occurred by chance if the corresponding experimental factor actually had no effect on concentration level. Thus, a small significance level (e.g. less than .10) indicates the factor likely has an effect on concentration level.

(.01) indicates statistical significance at the .01 level

(b) The corresponding coefficient represents a variance estimate rather than a systematic fixed difference in concentration levels.

## TABLE J-30. COMPARISON OF ACTUAL AND PREDICTED CONCENTRATIONS OF 2-NITROFLUORANTHENE, in ng/m$^3$

| | Woodburning Fireplace | Smoking | | | |
|---|---|---|---|---|---|
| | | Absent | | Present | |
| | | Actual | Predicted | Actual | Predicted |
| Gas-heated Homes | Not in Use | 0.0226 | 0.0227 | 0.1380 | 0.1350 |
| | | 0.0457 | 0.0445 | 0.0710 | 0.0710 |
| Electrically Heated Homes | In Use | 0.0372 | 0.0428 | -- | -- |

# APPENDIX K

# ABBREVIATIONS

# ABBREVIATIONS

| | |
|---|---|
| AC | Alternating current |
| AER | Air exchange rate |
| amp | Ampere |
| BaA | Benz[a]anthracene |
| BaP | Benzo[a]pyrene |
| BeP | Benzo[e]pyrene |
| B(g,h,i)P | Benzo[g,h,i]perylene |
| D | The effect of the specific sampling day |
| DMBA | Dimethyl benz[a]anthracene |
| E | Combined effects of all other factors not included in the model |
| ECD | Electron capture detector |
| EPA | Environmental Protection Agency |
| eV | Electron voltage |
| GC | Gas chromatography |
| H | The effect of the specific sampled home |
| HS | The effect of the type of heat source and appliances |
| log | Logarithm |
| L | The effect of the specific sampling location |
| ma | Miliampere |
| MAX | The highest observed concentrations of the target compounds |
| MID | Multiple ion detection |
| MIN | The lowest observed concentrations of the target compounds |
| MS | Mass spectrometry |
| N | The numbers of samples |
| NCI | Negative chemical ionization |
| 3-NF | 3-nitrofluoranthene |
| 2-NF | 2-nitrofluoranthene |
| 1-NP | 1-nitropyrene |
| O.D. | Outside diameter |
| ORNL | Oak Ridge National Laboratory |
| PAH | Polynuclear aromatic hydrocarbon |
| PCB | Polychlorinated biphenyl |
| PCI | Positive chemical ionization |
| PUF | Polyurethane foam |
| STD | The standard derivation |
| SM | The effect of the cigarette smoking |
| V | Volt |
| WB | The effect of woodburning fireplace in use |